Waste Generation, Waste Composition, and Differences in Source Separation in Three Town of Brookhaven Waste Districts

Prepared by:
Omkar Aphale
Department of Technology and Society

David J. Tonjes
Department of Technology and Society
Waste Reduction and Management Institute

December 2013
Stony Brook University
THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>i</td>
</tr>
<tr>
<td>List of Tables</td>
<td>ii</td>
</tr>
<tr>
<td>List of Figures</td>
<td>iii</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>iv</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>ES-1</td>
</tr>
<tr>
<td><strong>1.0 Introduction</strong></td>
<td>1</td>
</tr>
<tr>
<td>2.0 Materials and Methods</td>
<td>3</td>
</tr>
<tr>
<td>2.1 District Selection</td>
<td>3</td>
</tr>
<tr>
<td>2.2 General Sampling Procedures</td>
<td>6</td>
</tr>
<tr>
<td><strong>3.0 Results</strong></td>
<td>9</td>
</tr>
<tr>
<td>3.1 Data Analysis</td>
<td>9</td>
</tr>
<tr>
<td>3.1.1 Units</td>
<td>9</td>
</tr>
<tr>
<td>3.1.2 Data Analysis</td>
<td>10</td>
</tr>
<tr>
<td>3.2 Methodological Data</td>
<td>11</td>
</tr>
<tr>
<td>3.3 Global Results</td>
<td>15</td>
</tr>
<tr>
<td>3.3.1 Discards Data</td>
<td>16</td>
</tr>
<tr>
<td>3.3.2 Recyclables Data</td>
<td>18</td>
</tr>
<tr>
<td>3.3.2.1 Container Collections</td>
<td>18</td>
</tr>
<tr>
<td>3.3.2.2 Paper Recyclables Collections</td>
<td>19</td>
</tr>
<tr>
<td>3.3.2.3 Combined Curbside Recyclables Estimate</td>
<td>20</td>
</tr>
<tr>
<td>3.3.3 Separate Yard Waste Collection</td>
<td>21</td>
</tr>
<tr>
<td>3.3.4 Estimated Overall Waste Generation and Composition</td>
<td>21</td>
</tr>
<tr>
<td>3.4 Separate Discards Sorts Analysis</td>
<td>25</td>
</tr>
<tr>
<td>3.5 Separate Recyclables Sorts Analysis</td>
<td>29</td>
</tr>
<tr>
<td>3.6 Waste Generation Estimates</td>
<td>32</td>
</tr>
<tr>
<td><strong>32.0 Discussion</strong></td>
<td>37</td>
</tr>
<tr>
<td>4.1 Distinctions among the Districts</td>
<td>37</td>
</tr>
<tr>
<td>4.2 Recyclables Remaining in Discards</td>
<td>37</td>
</tr>
<tr>
<td>4.3 Yard Waste</td>
<td>38</td>
</tr>
<tr>
<td>4.4 Overall Concordance with Town Waste Rules</td>
<td>39</td>
</tr>
<tr>
<td>4.5 Implications for Single Stream Recycling</td>
<td>40</td>
</tr>
<tr>
<td>4.6 Food Waste</td>
<td>45</td>
</tr>
<tr>
<td>4.7 Textiles</td>
<td>47</td>
</tr>
<tr>
<td>4.8 Electronics</td>
<td>47</td>
</tr>
<tr>
<td>5.0 Findings</td>
<td>49</td>
</tr>
<tr>
<td>6.0 Recommendations</td>
<td>51</td>
</tr>
<tr>
<td>Appendix A. Statistical Analysis</td>
<td>53</td>
</tr>
<tr>
<td>Appendix B. Sampling Data</td>
<td>59</td>
</tr>
</tbody>
</table>
List of Tables

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2011 Recycling Performance of Brookhaven Waste Districts</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>General Characteristics of the Three Selected Districts</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Sorting Events</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Sorting Categories</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Sample Descriptions</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>Discard Tonnages</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>Recyclables Tonnages</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>Source Separated Yard Waste Deliveries</td>
<td>13</td>
</tr>
<tr>
<td>9</td>
<td>General Comparison, 2011 District Data to Sampling Period Data</td>
<td>16</td>
</tr>
<tr>
<td>10</td>
<td>Discards</td>
<td>17</td>
</tr>
<tr>
<td>11</td>
<td>Container Collection</td>
<td>19</td>
</tr>
<tr>
<td>12</td>
<td>Recyclables Separation</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td>Yard Waste Separation Rates, August-October 2012</td>
<td>21</td>
</tr>
<tr>
<td>14</td>
<td>Estimated Waste Composition for Curbside Collection</td>
<td>23</td>
</tr>
<tr>
<td>15</td>
<td>Estimated Waste Composition for Curbside Collection with Yard Waste Collection</td>
<td>24</td>
</tr>
<tr>
<td>16</td>
<td>Source Separation Percentages for Program Recyclables</td>
<td>24</td>
</tr>
<tr>
<td>A-1</td>
<td>PERMDISP Results</td>
<td>57</td>
</tr>
<tr>
<td>A-2</td>
<td>PERMANOVA Results</td>
<td>57</td>
</tr>
<tr>
<td>B-1</td>
<td>Net Weights of Materials Sampled from District 1</td>
<td>59</td>
</tr>
<tr>
<td>B-2</td>
<td>Net Weights of Materials Sampled from District 18</td>
<td>60</td>
</tr>
<tr>
<td>B-3</td>
<td>Net Weights of Materials Sampled from District 31</td>
<td>61</td>
</tr>
</tbody>
</table>
### List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Town of Brookhaven Waste Collection Districts</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Precipitation Events August-November 2012 Recorded by NWS at Islip</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>All Curbside Recyclables in Discards</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>Recyclables in Discards</td>
<td>26</td>
</tr>
<tr>
<td>5</td>
<td>Paper Recyclables in Discards</td>
<td>27</td>
</tr>
<tr>
<td>6</td>
<td>Container Recyclables in Discards</td>
<td>27</td>
</tr>
<tr>
<td>7</td>
<td>Plastics in Discards</td>
<td>28</td>
</tr>
<tr>
<td>8</td>
<td>Decomposable (mostly) Materials in Discards</td>
<td>28</td>
</tr>
<tr>
<td>9</td>
<td>Metal (mostly) Materials in Discards</td>
<td>29</td>
</tr>
<tr>
<td>10</td>
<td>Variability of Materials in the Container Set-outs</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>Composition of Containers in the Container Recyclables Set-outs</td>
<td>30</td>
</tr>
<tr>
<td>12</td>
<td>Distribution of Two Major Contaminants Found in the Container Recyclables Set-outs</td>
<td>31</td>
</tr>
<tr>
<td>13</td>
<td>Overall Contamination Levels in the Container Recyclables Separations</td>
<td>31</td>
</tr>
<tr>
<td>14</td>
<td>Distribution of Container Types in the Samples</td>
<td>32</td>
</tr>
<tr>
<td>15</td>
<td>Variability in Recyclables Set-outs</td>
<td>32</td>
</tr>
<tr>
<td>16</td>
<td>Waste Generation Rate for Curbside Discards and Recyclables</td>
<td>33</td>
</tr>
<tr>
<td>17</td>
<td>Percentage of Paper in Curbside Set-outs</td>
<td>34</td>
</tr>
<tr>
<td>18</td>
<td>Percentage of Containers in Curbside Set-outs</td>
<td>34</td>
</tr>
<tr>
<td>19</td>
<td>Curbside Source Separation Percentage, Paper</td>
<td>35</td>
</tr>
<tr>
<td>20</td>
<td>Curbside Source Separation Percentage, Containers</td>
<td>35</td>
</tr>
<tr>
<td>21</td>
<td>Source Separation Percentage for Recyclable Aluminum</td>
<td>36</td>
</tr>
<tr>
<td>22</td>
<td>Source Separation Percentage for #1 and #2 Plastic Containers</td>
<td>36</td>
</tr>
<tr>
<td>23</td>
<td>District 1 Paper Discards</td>
<td>42</td>
</tr>
<tr>
<td>24</td>
<td>District 1 Paper as a Percentage of Discards</td>
<td>42</td>
</tr>
<tr>
<td>25</td>
<td>District 18 and District 31 Paper Discards</td>
<td>43</td>
</tr>
<tr>
<td>26</td>
<td>District 18 and District 31 Paper as a Percentage of Discards</td>
<td>43</td>
</tr>
<tr>
<td>27</td>
<td>District 1 Container Discards</td>
<td>44</td>
</tr>
<tr>
<td>28</td>
<td>District 1 Containers as a Percentage of Discards</td>
<td>44</td>
</tr>
<tr>
<td>29</td>
<td>District 18 and District 31 Container Discards</td>
<td>45</td>
</tr>
<tr>
<td>30</td>
<td>District 18 and District 31 Containers as Percentage of Discards</td>
<td>45</td>
</tr>
<tr>
<td>31</td>
<td>Food Waste as a Percentage of Waste Generation</td>
<td>47</td>
</tr>
<tr>
<td>32</td>
<td>2011 Trend for District Waste Generation Rates and Recycling Percentages</td>
<td>50</td>
</tr>
<tr>
<td>A-1</td>
<td>Distances between Individual Replicate Samples and their Group Centroids; Inter-point Distance</td>
<td>54</td>
</tr>
</tbody>
</table>
Acknowledgements

The assistance of Bob Cerrato and Krista Greene (both at Stony Brook University) and operators for Hudson Baler/Recommunity and Island Transport is gratefully acknowledged. Michael DesGaines’s help, good cheer, and general assistance were essential for this project.

The Town of Brookhaven Department of Waste Management (Commissioner: Matt Miner; Chief Deputy Commissioner: Ed Hubbard; Deputy Commissioner: Christopher Andrade) provided financial resources and was instrumental in allowing the work to be conducted. Although the Town of Brookhaven supported the research described here, it does not necessarily reflect the view of the Town and no official endorsement should be inferred. The Town makes no warranties or representations as to the usability or suitability of the materials and the Town shall be under no liability whatsoever for any use made thereon.
Executive Summary

Recyclables source separation, as measured by the percentage of recyclables set out for regular collection compared to the total amounts of discards and recyclables set out for collection, has been a constant since the turn of the century, measured Town-wide for the Town of Brookhaven (New York). This plateau in one of the more important measures of recycling program effectiveness, at 11%-12%, hides a range of separation percentages in the 35 waste districts. Separation percentage is calculated as the sum of curbside collected paper and container recyclables divided by the sum of curbside collected disposed wastes and these recyclables. The data are not net values but reflect the tonnages measured at the scale house for different collection days. In 2011, for instance, the district percentages ranged from a low of 8% to a high of 20%.

We investigated differences in recyclables separation across this range by sorting discards and recyclables from three waste districts. District 1 has the highest separation percentage, and District 31 has among the lowest percentages. District 18 has a Town median percentage. We analyzed one sample of discards and one sample of container recyclables from each district for each collection event over a ten week period from August 20 to October 24, 2012 (another discards sample was analyzed November 15, 2012, after Superstorm Sandy, but those data are generally not discussed here). We generally followed published ASTM procedures (D-5231-92) for the sorts, and separated the materials into 14 different waste categories. Based on observations and records from the Town Materials Recovery Facility (MRF), we did not sort curbside collected paper recyclables; methodological issues made it difficult to sort separately collected yard wastes, and so we did not sort them, either.

We assumed that our samples represented the wastes delivered from each district for that collection period, and so we applied the percentage for each category to the total delivered tonnages to estimate waste composition for the entire district over each sampling period. The sampling period for discards either was a 4-day period (for Monday collections) or a 3-day collection (for Thursday collection), except for the Thursday collections after Labor Day and Columbus Day which were for one-week intervals (no collections were made on the holidays). Recyclables are collected on a staggered two-week schedule (meaning each container collection represented a 14 day generation period, as was the case for each paper collection). Separate yard
waste collections were made sporadically across the sampling period; we aggregated those data by month. The primary measures of wastes we used were “pounds per household per week” (lbs/HH/wk) and percentages.

Statistical measures were difficult to generate and interpret. The data sets generally did not conform to normal distributions due to the compositional heterogeneity of municipal solid waste, and variability in the amount of wastes collected each day. The differences in collection timing (twice a week for discards, bi-weekly for recyclables) meant that when overall waste generation data sets were created, either information was created by matching recyclables data with discards data or statistical power was lost by matching discards samples to the fewer recyclables collection data. We found that combining all sort data into a single data set was an illuminating way to examine the data, but eliminated the potential for formal statistical analysis. Therefore, most of our findings were based on professional judgements of interesting and important differences among the data sets, rather than differences determined by statistical significance measures. A fuller discussion of this is included in Appendix A.

Overall, District 1 had a higher source separation rate than the other two districts. District 1 also generated less waste overall. However, a greater percentage (and, by a less distinctive difference, a greater amount) of all waste generated in District 1 households was recyclable. District 1 was therefore not only more efficient at separating recyclables from other wastes, the residents had more recyclable materials available to separate. This implies that purchasing patterns and other waste generation processes, which have often been associated with demographic factors, result in a relatively recyclables rich waste stream in District 1, and then those residents comply more completely with Town requirements to separate those materials for recovery. The differences in waste generation and separation percentages are greatest for paper and glass, and are not as large across the districts for materials like aluminum and plastics.

All districts had unimpressive compliance rates with the two major recycling ordinances Town code. District 1 separated about half of the available curbside recyclables; District 18 separated about one-third; District 31 separated about one-quarter. During this time period, yard waste generation was not expected to be substantial (post-spring clean up time and early summer grass clipping generation maximums, and pre-leaf collection time). However, yard waste was a variable and sometimes large portion of the discards in all districts, and the total amount in
discards averaged over 5% in District 1 and was nearly 15% in District 18. Yard waste was found in nearly three-quarters of all our samples. The source separation percentage for yard waste was less than 50% for District 18 and District 31, although collections appear to have been made several times each month (we do not know how much of each district was serviced each time source separated yard wastes were collected, however). We believe that when large quantities of yard waste are generated that compliance with Town rules is better, as it is more difficult to sneak many bags of leaves into the discards than it is to slip a bag or two in.

The Town is changing its recyclables program to a single stream collection every week to increase convenience for Town residents, which has been said to increase participation and set-outs. We saw no consistent evidence of more or less recyclables in discards with proximity to the recyclables collection day, so this work provides no support for that hypothesis.

Food waste is perceived by many as a frontier that can be explored to increase recovery rates. Food waste was a significant element in discards. However, it does not seem likely that residents would comply better with requirements to separate food waste from other discards compared to containers (for instance). We believe containers are easier to identify and separate and so would expect that residents would separate these better. However, container separation rates were less than 50%, which suggests recovering as much as 50% of generated food waste might be difficult to achieve.

Poor compliance with Town source separation requirements mean more discarded recyclable materials, and discarded recyclables come at a cost. Assuming the data from these three districts hold for the rest of the Town, since around 30% of all discards were recyclable materials, the Town may be spending on the order of $5 million to transport and dispose items that might actually have a positive value if processed through the MRF. Only about 20% of aluminum cans, and 30% of #1 and #2 plastic containers are being recovered; this results in loss of $50/household in secondary market revenues each year (equivalent to about 15% of the annual household waste district fee). Yard waste included in discards can be managed less expensively by the Town's composting vendor. Therefore, the impacts of poor source separation on Town finances may very well be substantial.

The study suggests that there is good potential for greater recovery of recyclables by Town residents. Although we found no clear evidence that more frequent collection might
increase recyclables diversion, the adoption of single-stream recycling could revitalize public interest in the program and improve overall performance. Incentives such as RecycleBank or other positive re-inforcements, such as providing rebates to those found to be complying well with Town regulations, could persuade residents to participate better. A continued emphasis on education and awareness will also help those who are newly arrived in Town, or those who are not clear about the details of the recycling effort. Finally, we believe that there is a role for enforcement of the recycling code, as it is clear many do not pay any attention to what is required of them, and apparently have no concern regarding potential consequences of non-participation.
1. Introduction

In 2001, the Town of Brookhaven made a major modification to its residential collection program. The Town instituted a separate collection for yard wastes and banned collection of grass clippings. This should have segregated the major source of seasonality and variation in waste collection. The Town's source separation percentage (calculated as the sum of paper and container recyclables divided by the sum of disposed wastes and recyclables) has remained essentially flat since that time, ranging between 11% and 12%, despite continued education and outreach programs, including annual mailings, some mass media and targeted advertising, and use of the RecycleBank program (merchant redemptions and other rewards associated with higher recycling performance).

Individual waste districts vary from the generalized 11-12% Town-wide percentage, with some districts separating 20% or slightly more of their wastes, and a number of districts separating on the order of 8% of wastes. Informal inspections of wastes delivered to the transfer station suggest many recyclables are not being separated for recycling.

We thus sought to determine the efficiency of recyclers in the Town by measuring how much of available recyclables were being separated. We focused on differences, targeting wastes from a higher separation percentage district, a median separation percentage district, and a low separation percentage district. We also sorted delivered recyclables, which gave measures of compliance with Town guidance regarding proper recyclables separation. These field data were then combined with district collection data to create profiles of waste generation for each district.

Most studies of recycling behavior assume that differences in separation percentages result from differential sorting efficiencies: better recyclers separate a higher percentage of available recyclables for recovery. However, we were aware that there are some broad demographic differences between low and high separation percentage districts. Higher percentage districts tend to be wealthier and better educated. Differences in these demographic characteristics have been linked to differences in waste generation rates and waste composition. Therefore, we were also interested to see if some of the differences in recyclables source separation percentages were associated with differences in the amounts of recyclables available to be separated.
Fig. 1. Town of Brookhaven Waste Collection Districts
2. Materials and Methods

2.1. District Selection

There are 35 geographically distinct districts in the Town waste collection program (Fig. 1). To minimize sampling effort, we selected three districts that delivered discarded wastes to the Town Transfer Station on the Monday/Thursday collection cycle. We selected District 1, District 18, and District 31. District 1 had the greatest separation percentage of all 35 districts in 2012, District 18 ranked 15 (of 35), and District 31 ranked 33 (Table 1). District 1 is smaller than the other two districts, and its residents tend to be wealthier, and better educated (Table 2).

<table>
<thead>
<tr>
<th>WD</th>
<th>% Separated</th>
<th>Rank</th>
<th>WD</th>
<th>% Separated</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>1</td>
<td>19</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>3</td>
<td>20</td>
<td>11</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>9</td>
<td>21</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>22</td>
<td>22</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td>28</td>
<td>23</td>
<td>9</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>17</td>
<td>5</td>
<td>24</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>7</td>
<td>25</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>2</td>
<td>26</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>19</td>
<td>27</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>34</td>
<td>28</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>18</td>
<td>29</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>28</td>
<td>30</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>13</td>
<td>11</td>
<td>23</td>
<td>31</td>
<td>8</td>
<td>33</td>
</tr>
<tr>
<td>14</td>
<td>13</td>
<td>12</td>
<td>32</td>
<td>8</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>13</td>
<td>8</td>
<td>33</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
<td>21</td>
<td>34</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>17</td>
<td>13</td>
<td>14</td>
<td>35</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>18</td>
<td>12</td>
<td>15</td>
<td><strong>Town Mean</strong></td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. 2011 Recycling Performance of Brookhaven Waste Districts
<table>
<thead>
<tr>
<th>Carter</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td># Households (2012)</td>
<td>2,316</td>
<td>4,059</td>
<td>6,234</td>
</tr>
<tr>
<td>Population estimate*</td>
<td>6,173</td>
<td>16,365</td>
<td>26,163</td>
</tr>
<tr>
<td>2011 Separation Percentage</td>
<td>20.5%</td>
<td>12.2%</td>
<td>8.5%</td>
</tr>
<tr>
<td>2011 Discards (lbs/HH/wk)</td>
<td>58.8</td>
<td>74.3</td>
<td>69.6</td>
</tr>
<tr>
<td>2011 Paper Recyclables (lbs/HH/wk)</td>
<td>7.7</td>
<td>5.9</td>
<td>3.5</td>
</tr>
<tr>
<td>2011 Container Recyclables (lbs/HH/wk)</td>
<td>4.4</td>
<td>3.1</td>
<td>2.4</td>
</tr>
<tr>
<td>2011 Yard Waste (lbs/HH/wk)</td>
<td>14.1</td>
<td>17.4</td>
<td>12.4</td>
</tr>
<tr>
<td>2011 Separation Percentage (including Yard Waste)</td>
<td>35.9%</td>
<td>28.8%</td>
<td>22.3%</td>
</tr>
<tr>
<td>Median per capita Income**</td>
<td>51,796</td>
<td>34,207</td>
<td>36,963</td>
</tr>
<tr>
<td>Some College Education***</td>
<td>86.7%</td>
<td>62.7%</td>
<td>40.2%</td>
</tr>
<tr>
<td>Black Population*</td>
<td>1.1%</td>
<td>1.1%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Hispanic Population*</td>
<td>7.0%</td>
<td>11.4%</td>
<td>19.1%</td>
</tr>
</tbody>
</table>

* estimated based on interpolations from 2011 ACS (American Community Survey) data from census tracts that show partial or complete overlap with the geographic extents of waste districts; the following census tracts were used – CT 158002 for District 1; CT 158512, 158511, 58508 for District 18; and CT 159511, 159506, 159408, 159404 for District 31
** Derived from the selected census tracts (see above)
*** 25 years old and older

Table 2. General Characteristics of the Three Selected Districts

Town waste administrators also believed that the carting companies for these districts had better than usual compliance with various collection rules, such as avoiding using the same truck to collect from two districts on the same day (doing this would confuse our analysis). Although Districts 18 and 31 deliver wastes to the transfer station on the Monday/Thursday cycle, due to their large size they also deliver wastes on the Tuesday/Friday cycle as well. The second collection cycle on Tuesday/Friday was not sampled, although the delivery data were used to generate waste profiles. Sampling began August 20, 2012, and continued until November 15, 2012. Samples were not made on Labor Day (September 3) and Columbus Day (October 8) when no wastes were collected. Because of the disruption of sampling (no samples were collected October 25, the week of October 29, and the week of November 5) and the potential that storm debris would change the waste composition, the samples collected on November 15 were not included in the analysis, although we will note the data produced that day as appropriate. Therefore, the analyses that follow will report on 17 samples from each district (8 Monday samples, 9 Thursday samples). Table 3 lists the sampling dates.
<table>
<thead>
<tr>
<th>Sampling Date (m/dd)</th>
<th>Day</th>
<th>Days since previous collection</th>
<th>Discards</th>
<th>Recyclables</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/20 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/22 W</td>
<td>14</td>
<td></td>
<td>18, 31</td>
<td>1</td>
</tr>
<tr>
<td>8/23 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/27 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/29 W</td>
<td>14</td>
<td></td>
<td>1</td>
<td>18, 31</td>
</tr>
<tr>
<td>8/30 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/05 W</td>
<td>14</td>
<td></td>
<td>18, 31</td>
<td>1</td>
</tr>
<tr>
<td>9/06 Th</td>
<td>7</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/10 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/12 W</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/13 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/17 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/19 W</td>
<td>14</td>
<td></td>
<td>18, 31</td>
<td>1</td>
</tr>
<tr>
<td>9/20 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/24 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td>1</td>
<td>18, 31</td>
</tr>
<tr>
<td>9/26 W</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/27 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/01 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/03 W</td>
<td>14</td>
<td></td>
<td>18, 31</td>
<td>1</td>
</tr>
<tr>
<td>10/04 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/10 W</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/11 Th</td>
<td>7</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/15 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/17 W</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/18 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/22 M</td>
<td>4</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/24 W</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/15 Th</td>
<td>3</td>
<td>1, 18, 31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Sorting Events

District 1 is north of Middle Country Road, but Districts 18 and 31 are south of Middle Country Road. This means that they did not have similar recyclables collections. Instead, on the Wednesdays District 1 collected paper, Districts 18 and 31 collected containers; the following week, District 1 collected containers while Districts 18 and 31 collected paper. Container sampling began Wednesday, August 22, 2012 and continued weekly until October 24, 2012. The container deliveries from each district were sampled five times. Each pair of recyclables collections (paper and containers) can be associated with either four discards samples (the pair of weeks of August 20 and August 27, and the pair of weeks of September 17 and September 24) and or three discards samples (the pair of weeks of September 3 and September 10, the pair of
weeks of October 1 and October 8, and pair of the weeks of October 15 and October 22). See Table 3 for the containers sampling dates.

2.2. General Sampling Procedures

Modified ASTM protocols were followed. Specific trucks from each district were pre-identified. The Facilities Manager (Michael DesGaines) was notified when one had arrived at the scale house, and the transfer station was given notice to segregate the load. The wastes were mixed by the transfer station front-end loader for several minutes. A partial bucket was taken from the discard pile and brought to the vicinity of the residential C&D processing area. There, the load was spread. Wastes were sorted into 14 distinct categories (Table 4). Materials were not disaggregated, except that garbage bags and other waste holders were emptied. This means that containers and other packaging were counted in with food at times, and other packaging was contaminated by food. Containers were not drained of liquids. Multi-material pieces were sorted according to judgements of predominant material, although the broad categories of "organic" and "inorganic" removed some of the uncertainties associated with multi-materials. Bulk wastes were excluded from the samples through the selection of samples procedures (they did not fit into the bucket well), and very large objects were not encountered (such as garbage cans). Uncontainerized liquids were not included. Sorting continued until the entire pile had been sorted or it was estimated that more than 200 lbs had been sorted. Materials were stored in plastic bagged, 30-gal. CURBY containers, and weighed by electronic scale (data given in 0.2 lbs increments). Tare weights were used for each bucket.
<table>
<thead>
<tr>
<th>Categories</th>
<th>Materials included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed paper*</td>
<td>Newspaper, office paper, magazines, mail, boxboard (non-corrugated boxes)</td>
</tr>
<tr>
<td>Corrugated*</td>
<td>Corrugated boxes and brown/kraft paper bags</td>
</tr>
<tr>
<td>#1/#2 Plastic*</td>
<td>PET (#1) and HDPE (#2) rigid plastic containers</td>
</tr>
<tr>
<td>Plastic Bags</td>
<td>Included sheet plastic and garbage bags (included some retained food and other organic matter)</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td>Plastic containers and materials not #1 and #2 plastic containers</td>
</tr>
<tr>
<td>Yard waste</td>
<td>Branches, twigs, leaves, grass, flowers</td>
</tr>
<tr>
<td>Food waste</td>
<td>(included some packaging materials)</td>
</tr>
<tr>
<td>Wood</td>
<td>Manufactured wood: lumber, pallets, furniture</td>
</tr>
<tr>
<td>Other organics/combustibles</td>
<td>Textiles, rubber, leather, and other primarily burnable materials not included in the above component categories, especially soiled paper, diapers, food cartons</td>
</tr>
<tr>
<td>Ferrous*</td>
<td>Magnetic metal containers, aerosol cans</td>
</tr>
<tr>
<td>Aluminum*</td>
<td>Fabricated aluminum, aluminum cans, and aluminum foil</td>
</tr>
<tr>
<td>Glass*</td>
<td>Glass containers (broken or intact)</td>
</tr>
<tr>
<td>Other inorganics</td>
<td>Non-combustibles, such as rock, sand, dirt, concrete, ceramics, plaster, metals not containers, aerosol cans, or foil, sheet glass and other glass, bones</td>
</tr>
<tr>
<td>Electronics</td>
<td>Small appliances, electronic equipment</td>
</tr>
</tbody>
</table>

Table 4: Sorting Categories (* = recyclables)

Source separated paper recyclables were not sorted, due to low incidence of inappropriate materials, as determined by visual inspections and the long history of sorting recyclables at the MRF to create saleable products. Containers were sorted. Trucks were identified at the scale house, and the MRF was notified to segregate those loads. The container loads were mixed by loader for several minutes. A partial bucket load was selected from the pile and brought into the MRF to the segregated OCC area. There the materials were sorted into the same 14 categories as the discards. The segregated recyclables were entirely sorted each time.

Omkar Aphale (SBU), together with Michael DesGaines (TOB), devised the sampling plan and procedures, with some input from Robert Cerrato (SBU) and David Tonjes (SBU). Heavy equipment operators from Island Transportation separated the sampled discards from other wastes, and delivered the material to the sorting area. Operators for Hudson Baler/Recommunity, supervised by Kenny Bloom (MRF Supervisor), separated out the containers for sorting. Omkar Aphale was the primary sorter. Michael DesGaines assisted on a
number of occasions. David Tonjes helped twice, and Krista Greene (SBU) once. Appropriate health and safety precautions were taken by each sampler.

Paper recyclables and yard wastes were not sorted. Data used in these studies for source separated paper recyclables and yard waste were generated from scale house data under the assumption that these materials were composed entirely of mixed paper recyclables and yard waste, respectively.
3. Results

3.1. Data Analysis

3.1.1. Units

There are three units that are commonly used in studies of waste generation and waste characterization. They are percentages, per capita rates, and per household rates.

Percentage reports are useful for comparing results without concerns for the absolute amounts of materials under consideration. The proportionate valuations make comparisons easy to understand. However, aggregating percentages from different events can cause methodological issues unless weighting issues are addressed carefully.

Rates are commonly used in solid waste assessments. The most common in the US is per capita computations. However, the waste districts do not conform with census tracts, and certain housing types (multi-family housing, condominiums, and co-ops) are not included in the waste district. Therefore, per capita rates were not perceived to be best for this report.

Household rates are commonly used in European waste studies, and in certain US work. There is a prejudice against "household" as the base unit in solid waste analyses, partially because it is clear that all households do not have the same number of members, and some have many more members than others do; thus, equating waste generation from a household of ten to a household of a single person is clearly fraught with methodological peril. However, individuals are also capable of creating different amounts of waste (although perhaps not to the same degree). Households are clearly the unit of waste collection for curbside collection, and they are the billing unit for the waste districts (and so are carefully tracked). Therefore, we selected “per household” values (lbs/HH) instead of “per capita” values for this report.

We chose “week” as our unit of time. All calculations of lbs/HH were determined based upon the days from the previous collection day, and then calculated as lbs/HH/d. However, to prevent use of many values <1, we multiplied all of the daily rates by 7 to create weekly rates.

As will be discussed in the report, the per household data we used were not especially amenable to various manipulations that combined or separated values (which is something we were concerned about with percentage measurements, as discussed above). The same issues would have resulted if per capita measures had been used. The anomalies in data sets arise due to
differences in sample sizes, heterogeneities in wastes, and differences in the amount of wastes delivered on particular collection days. Depending upon the means of combining or separating the data sets, some of the differences could be magnified, affecting the way the wastes were characterized.

We generally used a mixture of percentage and HH/wk values, as best illustrated the condition we wanted to focus on.

In order to generate district data from the sampling data, the weights for each category of discards were converted to percentages of the whole sample. The percentages were then applied to the waste tonnage data (for the sampling period, one day for District 1 and two consecutive days for Districts 18 and 31, as collected by the scale house) to generate an estimate of the composition of wastes for the entire district for the collection event. This requires assuming the composition of the sample accurately reflected the composition of wastes generally generated across the district for that time period.

3.1.2. Data Analysis

Most studies of this kind, with replicate samples as is the case here, report data with measures of statistical significance. We have included a statistical analysis in Appendix A, but have not reported the data with significance markers in the main report. This is for several reasons:

1) the data sets generally did not conform to normal distributions, and were not transformable by functions into normal distributions. This resulted from the heterogeneity of MSW, and from the “batch” nature of discards. In a 200 lb. sample, a single 15 lb. bag of yard waste could skew the entire distribution of the sampling results. One closet clean-out could also bias a sample. Other waste generation phenomena similar to these were common. Therefore, we mostly used non-parametric statistical analyses. Unlike standard statistical analyses, where the comparison of the two sets often allows conclusions to be drawn about the mean values of the data sets, the output of non-parametric statistics is often not as clear, tending to be reports on the nature of the sample distributions or the ranking of samples in relation to each other.
2) there was a mismatch between the frequency of waste analyses and recyclables analyses. We will combine these data sets as needed to illustrate important processes. But combining them by reducing the number of waste data points to match the five recyclables data points for each district loses power from statistical analyses. We have generally assumed that the single-point recycling rates can be combined across the two week sampling period (assuming that recyclables generation rates are essentially constant between collections), but adding these non-unique data points creates significance for the 17-case model that did not always exist in the 5-case model. Yard wastes, which tended to be irregularly delivered in the latter weeks of each month, presented additional difficulties in being incorporated with the other collection data.

3) we think the identification of many differences among the data sets are compelling enough absent statistical analysis to address underlying, important issues.

### 3.2. Methodological Data

Table 5 presents information regarding the sampling effort. The sample weights tended to be lower than desired for District 1 and the container efforts, and there was considerable variance in the data, due to the imprecision of sample extraction from the delivered wastes associated with the payloader. The 18th sample (taken post-Sandy) did not cause any change in the overall sample descriptions.

<table>
<thead>
<tr>
<th></th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean ± Std. Dev. (lbs)</strong></td>
<td>171.6 ± 34.9</td>
<td>205.1 ± 55.9</td>
<td>210.1 ± 52.0</td>
</tr>
<tr>
<td><strong>Maximum (lbs)</strong></td>
<td>236.7</td>
<td>327.0</td>
<td>327.95</td>
</tr>
<tr>
<td><strong>Minimum (lbs)</strong></td>
<td>105.95</td>
<td>123.95</td>
<td>125.0</td>
</tr>
<tr>
<td><strong>Samples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td><strong>Containers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean (Std. Dev.) (lbs)</strong></td>
<td>172.8 ± 34.3</td>
<td>210.5 ± 58.8</td>
<td>206.1 ± 53.3</td>
</tr>
<tr>
<td><strong>Maximum (lbs)</strong></td>
<td>236.7</td>
<td>327.0</td>
<td>327.95</td>
</tr>
<tr>
<td><strong>Minimum (lbs)</strong></td>
<td>105.95</td>
<td>123.95</td>
<td>125.0</td>
</tr>
<tr>
<td><strong>Samples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 5. Sample Descriptions
Tables 6-8 show relevant scale house data. Note that when there were two collection days for discards, as was the rule for Districts 18 and 31 but rarely the case for District 1, we aggregated the tonnages, although wastes were only sorted on Mondays and Thursdays. This allowed computation of district-wide discards rates and percentages. The discard data had patterns of variation: “Monday” (Monday-Tuesday) deliveries exceed “Thursday” (Thursday-Friday) collections more than the expected 33% associated with the extra day of waste generation. The one-week collections for Columbus Day and for District 1 for Labor Day were about the same as the sum of the two preceding collection days, but the post-Labor Day collection in Districts 18 and 31 were heavier. The November post-Superstorm Sandy sampling date was associated with slightly heavier waste generation. The recyclables data are much more regular.

<table>
<thead>
<tr>
<th>Sample date (day)</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/20 (M)</td>
<td>40.93</td>
<td>80.29</td>
<td>126.93</td>
</tr>
<tr>
<td>8/23 (Th)</td>
<td>22.54</td>
<td>55.03</td>
<td>73.29</td>
</tr>
<tr>
<td>8/27 (M)</td>
<td>33.33</td>
<td>80.22</td>
<td>114.23</td>
</tr>
<tr>
<td>8/30 (Th)</td>
<td>23.29</td>
<td>54.44</td>
<td>74.56</td>
</tr>
<tr>
<td>9/06 (Th)</td>
<td>54.09</td>
<td>145.38</td>
<td>203.84</td>
</tr>
<tr>
<td>9/10 (M)</td>
<td>34.55</td>
<td>87.69</td>
<td>118.41</td>
</tr>
<tr>
<td>9/13 (Th)</td>
<td>22.62</td>
<td>52.71</td>
<td>71.63</td>
</tr>
<tr>
<td>9/17 (M)</td>
<td>28.8</td>
<td>81.06</td>
<td>108.37</td>
</tr>
<tr>
<td>9/20 (Th)</td>
<td>23.66</td>
<td>50.78</td>
<td>75.59</td>
</tr>
<tr>
<td>9/24 (M)</td>
<td>32.69</td>
<td>87.96</td>
<td>112.80</td>
</tr>
<tr>
<td>9/27 (Th)</td>
<td>20.19</td>
<td>48.58</td>
<td>69.68</td>
</tr>
<tr>
<td>10/01 (M)</td>
<td>30.52</td>
<td>82.63</td>
<td>107.29</td>
</tr>
<tr>
<td>10/04 (Th)</td>
<td>20.52</td>
<td>43.91</td>
<td>66.08</td>
</tr>
<tr>
<td>10/11 (Th)</td>
<td>48.08</td>
<td>121.14</td>
<td>181.09</td>
</tr>
<tr>
<td>10/15 (M)</td>
<td>30.25</td>
<td>75.07</td>
<td>107.69</td>
</tr>
<tr>
<td>10/18 (Th)</td>
<td>22.17</td>
<td>47.04</td>
<td>80.03</td>
</tr>
<tr>
<td>10/22 (M)</td>
<td>30.48</td>
<td>78.41</td>
<td>114.31</td>
</tr>
<tr>
<td>10/25* (Th)</td>
<td>18.97</td>
<td>44.42</td>
<td>68.73</td>
</tr>
<tr>
<td>11/15 (Th)</td>
<td>28.18</td>
<td>57.98</td>
<td>83.65</td>
</tr>
</tbody>
</table>

* no sample taken
M= Monday & Tuesday, Th = Thursday & Friday

Table 6. Discard Tonnages
<table>
<thead>
<tr>
<th>(m/dd)</th>
<th>District 1 Paper</th>
<th>District 18 Paper</th>
<th>District 31 Paper</th>
<th>District 1 Containers</th>
<th>District 18 Containers</th>
<th>District 31 Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/22</td>
<td>21.77</td>
<td>21.20</td>
<td>9.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/29</td>
<td>17.08</td>
<td></td>
<td></td>
<td></td>
<td>13.63</td>
<td>16.06</td>
</tr>
<tr>
<td>9/05</td>
<td>23.39</td>
<td>21.67</td>
<td>11.32</td>
<td></td>
<td>13.60</td>
<td>16.47</td>
</tr>
<tr>
<td>9/12</td>
<td>18.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/19</td>
<td>21.84</td>
<td>20.97</td>
<td>9.72</td>
<td></td>
<td>12.37</td>
<td>12.79</td>
</tr>
<tr>
<td>9/26</td>
<td>16.35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/03</td>
<td>23.40</td>
<td>23.86</td>
<td>10.14</td>
<td></td>
<td>11.52</td>
<td>15.20</td>
</tr>
<tr>
<td>10/10</td>
<td>17.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/24</td>
<td>18.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Recyclables Tonnages

<table>
<thead>
<tr>
<th></th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/20</td>
<td>11.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/22</td>
<td>9.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/23</td>
<td>18.97</td>
<td></td>
<td>51.87</td>
</tr>
<tr>
<td>8/24</td>
<td>13.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30.34</td>
<td>23.03</td>
<td>51.87</td>
</tr>
<tr>
<td>September</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/10</td>
<td>14.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/12</td>
<td></td>
<td></td>
<td>32.89</td>
</tr>
<tr>
<td>9/13</td>
<td></td>
<td></td>
<td>22.21</td>
</tr>
<tr>
<td>9/15</td>
<td></td>
<td></td>
<td>9.82</td>
</tr>
<tr>
<td>9/24</td>
<td>9.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/26</td>
<td></td>
<td></td>
<td>27.03</td>
</tr>
<tr>
<td>9/27</td>
<td>9.19</td>
<td>20.53</td>
<td>1.32</td>
</tr>
<tr>
<td>Total</td>
<td>33.98</td>
<td>52.56</td>
<td>61.24</td>
</tr>
<tr>
<td>October</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/15</td>
<td>8.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/18</td>
<td>9.73</td>
<td>21.25</td>
<td>38.08</td>
</tr>
<tr>
<td>10/19</td>
<td></td>
<td>10.83</td>
<td></td>
</tr>
<tr>
<td>10/25</td>
<td>9.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/31</td>
<td></td>
<td></td>
<td>66.16*</td>
</tr>
<tr>
<td>Total</td>
<td>28.44</td>
<td>32.08</td>
<td>38.08</td>
</tr>
<tr>
<td>Totals</td>
<td>92.76</td>
<td>107.67</td>
<td>151.19</td>
</tr>
</tbody>
</table>

* discounted as Sandy debris

Table 8. Source Separated Yard Waste Deliveries (tons)

Source separated yard waste is weighed in at the scale house and then delivered across the street from the Town Waste Management Facility for debagging and further management at Long Island Compost. The deliveries of source separated yard waste were not synchronous with either discards or recyclables periodicity. To address this, we aggregated the data by month
(Table 8). Note that the October 31 delivery from District 31 was not included with the October data. It was a post-Sandy delivery, and clearly part of the general debris management program conducted at that time which resulted in daily large deliveries of yard waste through November.

There was less rain than usual during the 10 week sampling program (5.20 in. as measured at Islip MacArthur Airport, compared to an expected 10-12 in.) (Fig. 2). There were seven precipitation events greater than 0.5” in the months of August-November, but two occurred before sampling started and one after the main 10 week effort was completed. No waste sample was obviously affected by rain, so the variation in tonnages received over the sampling period did not seem to be the result of weather effects.

Figure 2. Precipitation Events August-November 2012, (in./d) Recorded by NWS at Islip
3.3. Global Results

Our initial reporting will be drawn from aggregated data sets. Some of these do not rely on the sampling data but instead are drawn from scale house data. The others were created by combining all samples from each district to create a single aggregate sample.

One reason for presenting the data in this fashion is to decrease potential variance due to reliance on relatively few households in each discard analysis. Given waste generation rates of 40-60 lbs/HH/wk, the regular Monday-Thursday truck routes collected from 500-800 households per truck (assuming 8-10 ton deliveries). However, because selection of samples from the discards was not from a well-mixed sample, as the front-end loader mixing procedure did not break bags and also because garbage is cohesive (especially after being compressed), we estimate most samples were drawn from 6-12 distinct households. The combined sample, drawn from 17 collection events is certainly representative of wastes from more than 100 households, and creates a description that is potentially less biased by the practices of one or more households.

In addition, when summary data (mean-standard deviation data, for instance) are generated for the individual sampling events to characterize the entire sampling event, differences in the tonnages delivered for each sampling period are not retained: each sampling event is equally weighted. This results in skewed mean values. However, the individual sampling event data, and the combined sampling event data (see Section 3.6) provide important information regarding the variability of the data sets. Comparisons of the multiple datums also can create statistical measures such as statistical significance, which are important in the scientific community to identify those results that do not conform with other data, and so may have been generated by distinguishable processes.

The general sampling period waste characteristics agreed with data collected in 2011 for the districts (Table 9). There is excellent agreement in waste generation and recyclables separation rates, and the resulting separation percentages. Differences are seen for yard wastes (see Section 4.3) and the smaller amounts of collected yard wastes depressed overall recovery rates in the sampling period relative to 2011 data. However, overall the data suggest that the sampling period served as a suitable means of characterizing the wastes of these districts.
<table>
<thead>
<tr>
<th></th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011 Separation Percentage</td>
<td>20.5%</td>
<td>12.2%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Sampling Period Separation</td>
<td>20.3%</td>
<td>11.6%</td>
<td>8.8%</td>
</tr>
<tr>
<td>2011 Curbside Waste Generation (lbs/HH/wk)</td>
<td>58.8</td>
<td>74.3</td>
<td>69.6</td>
</tr>
<tr>
<td>Sampling Period Curbside Waste Generation (lbs/HH/wk)</td>
<td>58.7</td>
<td>74.1</td>
<td>66.4</td>
</tr>
<tr>
<td>2011 Paper Recyclables (lbs/HH/wk)</td>
<td>7.7</td>
<td>5.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Sampling Period Paper Recyclables (lbs/HH/wk)</td>
<td>7.6</td>
<td>5.5</td>
<td>3.5</td>
</tr>
<tr>
<td>2011 Container Recyclables (lbs/HH/wk)</td>
<td>4.4</td>
<td>3.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Sampling Period Container Recyclables (lbs/HH/wk)</td>
<td>4.3</td>
<td>3.1</td>
<td>2.4</td>
</tr>
<tr>
<td>2011 Yard Waste (lbs/HH/wk)</td>
<td>14.1</td>
<td>17.4</td>
<td>12.4</td>
</tr>
<tr>
<td>Sampling Period Yard Waste (lbs/HH/wk)</td>
<td>6.1</td>
<td>4.0</td>
<td>3.7</td>
</tr>
<tr>
<td>2011 Separation Percentage (with Yard Waste)</td>
<td>35.9%</td>
<td>28.8%</td>
<td>22.3%</td>
</tr>
<tr>
<td>Sampling Period Separation Percentage (with Yard Waste)</td>
<td>27.8%</td>
<td>16.2%</td>
<td>13.6%</td>
</tr>
</tbody>
</table>

Table 9. General Comparison, 2011 District Data to Sampling Period Data

3.3.1. Discards Data (Table 10)

Using the per household rate computations, District 18 discarded the most, and District 1 discarded the least. The composition of discards was generally similar as measured by household rates. District 1 discarded ~ 2 lbs/HH/wk fewer recyclables than Districts 18 and 31. The difference in recyclable containers was ~ 1 lb/HH/wk, and the difference in paper recyclables was a little less, mostly due to greater newspaper discards in Districts 18 and 31. District 31 discarded more film plastic, and District 18 discarded more rigid plastic. Much of the difference in overall discard rates resulted from differences in yard waste discards, with District 18 discarding much more than District 31 (~5 lbs/HH/wk more); District 31 discarded considerably more than District 1 (more than 2 lbs/HH/wk). Districts 18 and 31 also discarded more organic waste than was discarded in District 1.

Discard relationships were very different when considered as percentages of the waste stream, rather than as rates. Nearly one-third of all discards in District 1 were recyclable materials, whereas they comprised a little more than a quarter of the discards in District 18 and 31. The differences were mostly in the paper categories, with District 1 discarding a greater percentage of both newspaper and corrugated cardboard than Districts 18 and 31. There were differences in the distributions of discards accounted for by yard waste, food, and wood, although the sum of all three categories was approximately 30% for all districts. Glass containers were a bigger portion of discards in District 1 compared to Districts 18 and 31.
<table>
<thead>
<tr>
<th>Categories</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Paper*</td>
<td>10.73</td>
<td>12.17</td>
<td>11.36</td>
</tr>
<tr>
<td></td>
<td>22.9%</td>
<td>18.6%</td>
<td>18.8%</td>
</tr>
<tr>
<td>Mixed paper*</td>
<td>6.52</td>
<td>7.4</td>
<td>7.21</td>
</tr>
<tr>
<td></td>
<td>13.9%</td>
<td>11.3%</td>
<td>11.9%</td>
</tr>
<tr>
<td>Corrugated*</td>
<td>4.21</td>
<td>4.77</td>
<td>4.15</td>
</tr>
<tr>
<td></td>
<td>9.0%</td>
<td>7.3%</td>
<td>6.9%</td>
</tr>
<tr>
<td>#1/#2 Plastic*</td>
<td>1.71</td>
<td>2.06</td>
<td>2.36</td>
</tr>
<tr>
<td></td>
<td>3.7%</td>
<td>3.1%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Plastic Bags</td>
<td>2.87</td>
<td>3.99</td>
<td>5.02</td>
</tr>
<tr>
<td></td>
<td>3.7%</td>
<td>6.1%</td>
<td>8.4%</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td>2.16</td>
<td>3.76</td>
<td>2.47</td>
</tr>
<tr>
<td></td>
<td>4.6%</td>
<td>5.7%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Yard waste</td>
<td>2.58</td>
<td>9.45</td>
<td>4.70</td>
</tr>
<tr>
<td></td>
<td>5.5%</td>
<td>14.4%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Food waste</td>
<td>7.70</td>
<td>6.95</td>
<td>8.26</td>
</tr>
<tr>
<td></td>
<td>15.3%</td>
<td>10.7%</td>
<td>13.7%</td>
</tr>
<tr>
<td>Wood</td>
<td>4.24</td>
<td>3.37</td>
<td>5.16</td>
</tr>
<tr>
<td></td>
<td>9.1%</td>
<td>5.1%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Other organics/ combustibles</td>
<td>9.51</td>
<td>16.09</td>
<td>14.37</td>
</tr>
<tr>
<td></td>
<td>20.3%</td>
<td>24.6%</td>
<td>23.6%</td>
</tr>
<tr>
<td>Ferrous*</td>
<td>0.79</td>
<td>1.35</td>
<td>1.61</td>
</tr>
<tr>
<td></td>
<td>1.7%</td>
<td>2.1%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Aluminum*</td>
<td>0.48</td>
<td>0.56</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>1.0%</td>
<td>0.9%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Glass*</td>
<td>1.53</td>
<td>1.30</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>3.3%</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Other inorganics</td>
<td>2.59</td>
<td>4.13</td>
<td>2.97</td>
</tr>
<tr>
<td></td>
<td>5.5%</td>
<td>6.3%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Electronics</td>
<td>0.49</td>
<td>0.30</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>1.0%</td>
<td>0.5%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Container Recyclables</td>
<td>4.50</td>
<td>5.26</td>
<td>5.80</td>
</tr>
<tr>
<td></td>
<td>9.6%</td>
<td>8.0%</td>
<td>9.6%</td>
</tr>
<tr>
<td>All recyclables</td>
<td>15.23</td>
<td>17.44</td>
<td>17.15</td>
</tr>
<tr>
<td></td>
<td>32.5%</td>
<td>26.6%</td>
<td>28.3%</td>
</tr>
<tr>
<td>Total</td>
<td>46.80</td>
<td>65.50</td>
<td>60.55</td>
</tr>
</tbody>
</table>

* = recyclable materials

Table 10. Discards (lbs/HH/wk)
3.3.2. Recyclables Data

3.3.2.1. Container Collections (Table 11)

There were some distinct differences in the amount (and composition) of container recyclables collected from the three districts. More material was set out in District 1 (4.37 lbs/HH/wk) than in either District 18 (3.16 lbs/HH/wk) or District 31 (2.42 lbs/HH/wk). Contaminants, defined as materials not #1 or #2 plastic containers, ferrous containers or aerosol cans, aluminum containers or foil, or glass containers, were greatest in Districts 1 and 18 by rate (~0.5 lbs/HH/wk) and less in District 31 (0.34 lbs/HH/wk), but in terms of percentages of the set-outs, District 1 had the least contamination level (a little less than 10%) and District 31 had the greatest (a little more than 15%). If the operator of the MRF is able to recover all recyclable paper delivered with containers and processed through the container line, then the amount of delivered recyclable materials increases slightly, and the percentage of acceptable materials also increases slightly.

Glass was the cause of differences in recyclable container rates, although percentage differences were observable among the districts in both glass and plastic containers. Rigid plastics were by far the greatest contaminant material (note the current operator has found markets for these materials, although they are not officially part of the Town source separation program). Film plastics (mostly bags) were also a notable contaminant, and is recoverable under certain conditions.
<table>
<thead>
<tr>
<th>Categories</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed paper**</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Corrugated**</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.6%</td>
</tr>
<tr>
<td>#1/#2 Plastic*</td>
<td>0.84</td>
<td>0.85</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>19.4%</td>
<td>27.2%</td>
<td>34.3%</td>
</tr>
<tr>
<td>Plastic Bags</td>
<td>0.16</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>3.6%</td>
<td>2.7%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td>0.23</td>
<td>0.34</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>5.3%</td>
<td>10.8%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Yard waste</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Food waste</td>
<td>0.01</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>0</td>
<td>0.01</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.2%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Other organics/ combustibles</td>
<td>0</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Ferrous*</td>
<td>0.37</td>
<td>0.35</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>8.7%</td>
<td>11.1%</td>
<td>13.1%</td>
</tr>
<tr>
<td>Aluminum*</td>
<td>0.14</td>
<td>0.11</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>3.3%</td>
<td>3.4%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Glass*</td>
<td>2.51</td>
<td>1.31</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>58.0%</td>
<td>41.9%</td>
<td>35.3%</td>
</tr>
<tr>
<td>Other inorganics</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.4%</td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.3%</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Correctly-sorted recyclables</td>
<td>3.86</td>
<td>2.61</td>
<td>2.10</td>
</tr>
<tr>
<td></td>
<td>89.4%</td>
<td>83.6%</td>
<td>86.8%</td>
</tr>
<tr>
<td>All recyclable materials</td>
<td>3.91</td>
<td>2.64</td>
<td>2.12</td>
</tr>
<tr>
<td></td>
<td>90.5%</td>
<td>84.4%</td>
<td>87.6%</td>
</tr>
<tr>
<td>Total</td>
<td>4.32</td>
<td>3.13</td>
<td>2.42</td>
</tr>
</tbody>
</table>

* Recyclable containers  ** recyclable material but contaminant in the container collection

Table 11. Container Collection (lbs/HH/wk)

3.3.2.2. Paper Recyclables Collections

The paper recyclables were not sorted. The amount of paper recyclables was determined using data provided by the scale house, from district collection trucks. District 1 had much higher separation rates, 7.58 lbs/HH/wk. District 18 had less, 5.50 lbs/HH/wk. District 31 had less than District 18, separating 3.45 lbs/HH/wk.
3.3.2.3. Combined Curbside Recyclables Estimate (Table 12)

We created a hypothetical combined curbside recyclables sample by assuming that the ratio of delivered tons of paper and tons of container separation over the two week periods would be reflected in such a sample. Since District 1 separated paper and containers at greater rates than the other two districts, it had the greatest combined separation rate. District 18 separated material better than District 31, which separated all materials at about half the rate of District 1. All together, non-recyclable materials constituted ~5% of the recyclables set-outs.

<table>
<thead>
<tr>
<th>Categories</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total paper*</td>
<td>7.63</td>
<td>5.55</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>64.1%</td>
<td>64.3%</td>
<td>59.6%</td>
</tr>
<tr>
<td>Mixed paper**</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Corrugated**</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td>#1/#2 Plastic*</td>
<td>0.84</td>
<td>0.85</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>7.1%</td>
<td>9.8%</td>
<td>14.0%</td>
</tr>
<tr>
<td>Plastic Bags</td>
<td>0.16</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>1.3%</td>
<td>1.0%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td>0.23</td>
<td>0.34</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>1.9%</td>
<td>3.9%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Yard waste</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Food waste</td>
<td>0.01</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.1%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wood</td>
<td>0</td>
<td>0.01</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Other organics/ combustibles</td>
<td>0</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Ferrous*</td>
<td>0.37</td>
<td>0.35</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>3.2%</td>
<td>4.0%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Aluminum*</td>
<td>0.14</td>
<td>0.11</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>1.2%</td>
<td>1.2%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Glass*</td>
<td>2.51</td>
<td>1.31</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>21.1%</td>
<td>15.1%</td>
<td>14.4%</td>
</tr>
<tr>
<td>Other inorganics</td>
<td>0</td>
<td>0.04</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.5%</td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Container recyclables</td>
<td>3.87</td>
<td>2.60</td>
<td>2.08</td>
</tr>
<tr>
<td></td>
<td>32.5%</td>
<td>30.1%</td>
<td>35.4%</td>
</tr>
<tr>
<td>All recyclable materials</td>
<td>11.44</td>
<td>8.12</td>
<td>5.56</td>
</tr>
<tr>
<td></td>
<td>96.1%</td>
<td>94.1%</td>
<td>94.8%</td>
</tr>
<tr>
<td>Total</td>
<td>11.90</td>
<td>8.63</td>
<td>5.87</td>
</tr>
</tbody>
</table>

* Recyclable materials ** only in container collection (considered as contaminant)

Table 12. Recyclables Separation (lbs/HH/wk)
3.3.3. **Separate Yard Waste Collection**

We did not sort any collected yard waste. Deliveries were irregular from each district, but generally occurred later in the month. We created monthly totals for deliveries, and estimated per household separation rates by assuming the collections occurred over the entire month (not just our sampling period). Separation rates were greatest in District 1, and more similar for District 18 and 31 (Table 13).

<table>
<thead>
<tr>
<th>District</th>
<th>Tons Collected</th>
<th>Separation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>92.76</td>
<td>6.09</td>
</tr>
<tr>
<td>18</td>
<td>107.67</td>
<td>4.04</td>
</tr>
<tr>
<td>31</td>
<td>151.19</td>
<td>3.69</td>
</tr>
</tbody>
</table>

Table 13. Yard Waste Separation Rates (lbs/HH/wk), August-October 2012

3.3.4. **Estimated Overall Waste Generation and Composition (Tables 14-16)**

Once discards and recyclables have been estimated for the sampling period, overall waste generation amounts and composition can also be estimated. We accomplished this by first combining discards and curbside recyclables, and then we added estimates from the separate yard waste collections.

Recyclable paper was the greatest single waste constituent in all three districts, and its waste generation rate was not very different in District 1 and 18, and was much less in District 31. Paper constituted a much larger proportion of wastes in District 1 than in Districts 18 and 31. Undifferentiated organic wastes was the second largest element for each district, nearly matching recyclable paper in Districts 18 and 31. Recyclable containers was another major constituent, generated at consistent rates across the three districts as a single category (although generation rates for plastics, glass, and, to a lesser extent, ferrous, varied among the districts). Food waste also was a large element of the waste stream; its generation rate varied with District 31 generating the most, more than 1 lb/HH/wk more than in District 1 and District 18, although the proportion of waste that was sorted as food was similar in Districts 1 and 31. A notable amount of yard waste, nearly 10 lbs/HH/wk, was discarded in District 18 (twice the rate of generation in District 31, and four times that of District 1). It was impossible to determine from the records we
had whether some aspect of that high discard rate was attributable to the carters collecting source-separated yard waste with discards, rather than making a separate collection trip.

Separation rates and recovery proportions were greatest in District 1. Overall, a greater proportion of containers compared to recyclable paper was separated in each district. District 1 separated a something less than 50% of the primary recyclable materials, District 18 about one-third, and District 31 about one-quarter. Glass was the only single constituent where separation percents were greater than 50% (in Districts 1 and 18).

When the monthly yard waste collection totals are included, because overall waste generation increases between 5% (District 18) to nearly 10% (District 1), the percentages of the waste stream comprised by all materials decline (except for yard waste, of course). Yard waste, considered on a Town-wide annual basis (~35,000 tons/yr) is ~ 12 lbs/HH/wk, so the collections recorded during the sampling period were less than might be expected (considering the annual rates). Therefore, since the discards and curbside recyclables data for the sampling period appear to be consistent with annual rates, it is likely that waste generation composition percentages considered on an annual basis would be lower than those reported below in Table 15 with all yard wastes factored in. However, it should also be realized that our assessment does not include other residential waste streams, such as separately collected bulky wastes, white goods, drop-off materials (including waste oil and electronic recyclables), household hazardous wastes, drop-off yard wastes, and other materials, which in total may account for on the order of 5% of waste generation (based on amounts reported in the annual reports).

We define the curbside programs as the separate collections of discards, paper and container recyclables, and yard waste. In them, recyclable materials (recyclables and yard waste) in total account for between 26 and 33 lbs/HH/wk, which ranges from 37% to a little more than 50% of total materials. District 1 generates more recyclable materials than the other two districts, both in terms of rates and in percentage of the waste stream. The percentage of these materials separated for recovery ranges from a little more than 50% in District 1 to 43% in District 18 to a little more than 36% in District 31. Individual materials source separated at percentages greater than 50% include yard waste and glass in District 1 and glass in District 18. Yard waste has the greatest source separation percentage in District 31, at 44%, and in general is the material that is best separated by residents (glass tends to be second best). The material with
the poorest separation percentage is aluminum (14% in District 31, 16% in District 18, 23% in District 1) and ferrous has lower separation percentages in District 31 (16%) and District 18 (20%). In District 31, 23.5% of paper is separated for recovery, which is lower than in the other two districts.

<table>
<thead>
<tr>
<th>Categories</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total paper*</td>
<td>18.35</td>
<td>17.72</td>
<td>14.85</td>
</tr>
<tr>
<td></td>
<td>31.3%</td>
<td>23.9%</td>
<td>22.4%</td>
</tr>
<tr>
<td>#1/#2 Plastic*</td>
<td>2.55</td>
<td>2.91</td>
<td>3.18</td>
</tr>
<tr>
<td></td>
<td>4.3%</td>
<td>3.9%</td>
<td>4.8%</td>
</tr>
<tr>
<td>Plastic Bags</td>
<td>3.03</td>
<td>4.07</td>
<td>5.09</td>
</tr>
<tr>
<td></td>
<td>5.2%</td>
<td>5.5%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td>2.38</td>
<td>4.09</td>
<td>2.65</td>
</tr>
<tr>
<td></td>
<td>4.1%</td>
<td>5.5%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Yard waste*</td>
<td>2.58</td>
<td>9.45</td>
<td>4.70</td>
</tr>
<tr>
<td></td>
<td>4.4%</td>
<td>12.8%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Food waste</td>
<td>7.15</td>
<td>6.98</td>
<td>8.30</td>
</tr>
<tr>
<td></td>
<td>12.2%</td>
<td>9.4%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Wood</td>
<td>4.24</td>
<td>3.38</td>
<td>5.19</td>
</tr>
<tr>
<td></td>
<td>7.2%</td>
<td>4.6%</td>
<td>7.8%</td>
</tr>
<tr>
<td>Other organics/ combustibles</td>
<td>9.51</td>
<td>16.09</td>
<td>14.32</td>
</tr>
<tr>
<td></td>
<td>16.2%</td>
<td>21.7%</td>
<td>21.6%</td>
</tr>
<tr>
<td>Ferrous*</td>
<td>1.17</td>
<td>1.69</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td>2.0%</td>
<td>2.3%</td>
<td>2.9%</td>
</tr>
<tr>
<td>Aluminum*</td>
<td>0.62</td>
<td>0.66</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>1.1%</td>
<td>0.9%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Glass*</td>
<td>4.04</td>
<td>2.60</td>
<td>2.07</td>
</tr>
<tr>
<td></td>
<td>6.9%</td>
<td>3.5%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Other inorganics</td>
<td>2.59</td>
<td>4.17</td>
<td>2.97</td>
</tr>
<tr>
<td></td>
<td>4.4%</td>
<td>5.6%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Electronics</td>
<td>0.50</td>
<td>0.30</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>0.9%</td>
<td>0.4%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Container recyclables</td>
<td>8.37</td>
<td>7.86</td>
<td>7.87</td>
</tr>
<tr>
<td></td>
<td>14.3%</td>
<td>10.6%</td>
<td>11.9%</td>
</tr>
<tr>
<td>All recyclable materials</td>
<td>26.68</td>
<td>25.56</td>
<td>22.64</td>
</tr>
<tr>
<td></td>
<td>45.4%</td>
<td>34.5%</td>
<td>34.1%</td>
</tr>
<tr>
<td>Total</td>
<td>58.70</td>
<td>74.13</td>
<td>66.42</td>
</tr>
</tbody>
</table>

* materials designated by the Town for source separation

Table 14. Estimated Waste Composition for Curbside Collection (lbs/HH/wk)
<table>
<thead>
<tr>
<th>Categories</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total paper*</td>
<td>18.35</td>
<td>17.72</td>
<td>14.85</td>
</tr>
<tr>
<td></td>
<td>28.3%</td>
<td>22.7%</td>
<td>21.2%</td>
</tr>
<tr>
<td>#1/#2 Plastic*</td>
<td>2.55</td>
<td>2.91</td>
<td>3.18</td>
</tr>
<tr>
<td></td>
<td>3.9%</td>
<td>3.7%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Plastic Bags</td>
<td>3.03</td>
<td>4.07</td>
<td>5.09</td>
</tr>
<tr>
<td></td>
<td>4.7%</td>
<td>5.2%</td>
<td>7.3%</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td>2.38</td>
<td>4.09</td>
<td>2.65</td>
</tr>
<tr>
<td></td>
<td>3.7%</td>
<td>5.2%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Yard waste*</td>
<td>8.67</td>
<td>13.49</td>
<td>8.39</td>
</tr>
<tr>
<td></td>
<td>13.4%</td>
<td>17.3%</td>
<td>12.0%</td>
</tr>
<tr>
<td>Food waste</td>
<td>7.15</td>
<td>6.98</td>
<td>8.30</td>
</tr>
<tr>
<td></td>
<td>11.0%</td>
<td>8.9%</td>
<td>11.8%</td>
</tr>
<tr>
<td>Wood</td>
<td>4.24</td>
<td>3.38</td>
<td>5.19</td>
</tr>
<tr>
<td></td>
<td>6.5%</td>
<td>4.3%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Other organics/ combustibles</td>
<td>9.51</td>
<td>16.09</td>
<td>14.32</td>
</tr>
<tr>
<td></td>
<td>14.7%</td>
<td>20.6%</td>
<td>20.4%</td>
</tr>
<tr>
<td>Ferrous*</td>
<td>1.17</td>
<td>1.69</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td>1.8%</td>
<td>2.2%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Aluminum*</td>
<td>0.62</td>
<td>0.66</td>
<td>0.70</td>
</tr>
<tr>
<td></td>
<td>1.0%</td>
<td>0.9%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Glass*</td>
<td>4.04</td>
<td>2.60</td>
<td>2.07</td>
</tr>
<tr>
<td></td>
<td>6.2%</td>
<td>3.3%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other inorganics</td>
<td>2.59</td>
<td>4.17</td>
<td>2.97</td>
</tr>
<tr>
<td></td>
<td>4.0%</td>
<td>5.3%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Electronics</td>
<td>0.50</td>
<td>0.30</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>0.8%</td>
<td>0.4%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Container recyclables</td>
<td>8.37</td>
<td>7.86</td>
<td>7.87</td>
</tr>
<tr>
<td></td>
<td>12.9%</td>
<td>10.1%</td>
<td>11.2%</td>
</tr>
<tr>
<td>All source-separable materials</td>
<td>32.77</td>
<td>29.59</td>
<td>26.34</td>
</tr>
<tr>
<td></td>
<td>50.6%</td>
<td>37.9%</td>
<td>37.6%</td>
</tr>
<tr>
<td>Total</td>
<td>64.80</td>
<td>78.16</td>
<td>70.11</td>
</tr>
<tr>
<td>* materials designated by the Town for source separation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 15. Estimated Waste Composition for Curbside Collection with Yard Waste Collection (lbs/HH/wk)

<table>
<thead>
<tr>
<th>Categories</th>
<th>District 1</th>
<th>District 18</th>
<th>District 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total paper*</td>
<td>41.5%</td>
<td>31.3%</td>
<td>23.5%</td>
</tr>
<tr>
<td>#1/#2 Plastic*</td>
<td>33.0%</td>
<td>29.1%</td>
<td>25.8%</td>
</tr>
<tr>
<td>Yard waste</td>
<td>70.3%</td>
<td>29.9%</td>
<td>44.0%</td>
</tr>
<tr>
<td>Ferrous*</td>
<td>32.1%</td>
<td>20.4%</td>
<td>16.4%</td>
</tr>
<tr>
<td>Aluminum*</td>
<td>23.1%</td>
<td>15.8%</td>
<td>14.0%</td>
</tr>
<tr>
<td>Glass*</td>
<td>62.1%</td>
<td>50.1%</td>
<td>40.7%</td>
</tr>
<tr>
<td>Container recyclables</td>
<td>46.2%</td>
<td>33.0%</td>
<td>26.4%</td>
</tr>
<tr>
<td>Curbside recyclables</td>
<td>42.9%</td>
<td>31.8%</td>
<td>24.2%</td>
</tr>
<tr>
<td>All source-separable materials</td>
<td>54.9%</td>
<td>42.8%</td>
<td>36.3%</td>
</tr>
</tbody>
</table>

Table 16. Source Separation Percentages for Program Recyclables
3.4. Separate Discards Sorts Analysis (Figures 3-9)

The discussion above aggregated the 17 (or 18) distinct sampling events for each district. Considering the sampling events as a set of distinct events generates data that, considered as a whole, is not very different from the aggregated data. We focused on results from the set of 17 consecutive discard samples; the means from the 17 samples are essentially the same as the values reported above, in particular. However, considering the discrete sampling events allows for measures of variability to be generated, such as standard deviation and maxima and minima. This means of analysis also supports the development of statistical significance inferences; these are presented in Appendix A.

Yard waste was extremely variable; a number of samples contained no yard waste (5 of 17 in District 1, 2 of 17 in District 18, and 6 of 17 in District 31), but others contained substantial amounts (one sample from District 18 contained the equivalent of 20 lbs/HH/wk, constituting over one-third of the sample), and standard deviations greater than mean value of yard waste generation were found for Districts 1 and 31. “Other inorganic” wastes were also variable, with the standard deviation exceeding the mean for District 18 and nearly doing so for District 1 and 31. At least 20% of all samples were materials that have been designated for source separation according to Town Code (paper, containers, and yard waste). More than half of the sample was recyclable in three samples from Districts 1 and 18, and in one sample from District 31.
Figure 3. All Curbside Recyclables in Discards

Figure 4. Recyclables in Discards
Figure 5. Paper Recyclables in Discards (“paper” = mixed paper, “corr.” = corrugated paper)

Figure 6. Container Recyclables in Discards (“#1 & #1 Pl.” = PET and HDPE plastics, “iron” = ferrous containers and aerosol cans, “Alum.” = aluminum containers and foil)
Figure 7. Plastics in Discards ("bags" – plastic film, #1 & #2" = PET and HDPE containers, “Rigid” = rigid plastics)

Figure 8. Decomposable (mostly) Materials in Discards ("Organics" = other organics)
3.5. Separate Recyclables Sorts Analysis (Figures 10-15)

The amounts of source-separated recyclables collected in each district were much more consistent than the discards collections. The composition of the container collections varied considerably. Three of five samples were more than 50% glass for District 1, with two samples being more than 70% glass. However, another sample was nearly 50% plastic containers. There was one sample in District 18 that was more than 50% glass, and one in District 31 that was nearly 50% glass; both districts also had samples that were more than 50% plastic containers, too. At least some of these data patterns resulted from only four categories of material that should have been set out in the container source separation, relatively small amounts of metal containers (which constituted two of the four categories of “proper” set-outs), and relatively low levels of contamination in these set-outs. Thus, it is likely that glass or plastic containers would dominate the samples.

Combining container composition data with the paper collection tonnages resulted in consistent recyclables collection patterns for the two-week cycles. The consistency in the data allows for clear identification of differences among the districts. Paper is consistently and clearly the major recyclable collected curbside, and the amounts of materials collected parallel the source separation percentages calculated for each district.
Figure 10. Variability of Materials in the Container Set-outs

Figure 11. Composition of Containers in the Container Recyclables Set-outs
Figure 12. Distribution of Two Major Contaminants Found in the Container Recyclables Set-outs

Figure 13. Overall Contamination Levels in the Container Recyclables Separations
3.6. Variability in Waste Generation Estimates

There is a mismatch in the frequency of discards and recyclables collections. This resulted in 17 samples from discards, and five waste characterizations of source-separated materials. In order to develop overall waste stream characterizations, either discards samples needed to be aggregated into five samples to match the recyclables samples, or, on the assumption that recyclables waste generation over the two-week cycle was constant, the five
recyclables samples needed to be multiplied to 17 samples. In the first instance, variability associated with the 17 sampling events is lost. In the second, information is created due to multiple applications of single datums.

Variability in the computed values generated by an inability to account for different tonnages managed in each event make it unclear if some of the distinctions found in 3.3.4 for the aggregated samples should be considered to be reliable. The mean values for the aggregate, five-sample, and 17-sample data sets tend to vary little but measures of standard deviation, which reflects differences among the samples, tend to be greater when more samples were considered, suggesting differences in the delivered tonnages have not been properly accounted for.

Therefore, the data sets presented in Figures 16-22 tend to show increasing variability with more sampling. Some of the data sets show notable changes in computed means with more samples considered (see Figures 19, 21, and 22, for instance). This is not an artefact of adding data by applying the same recyclables data to multiple discards data sets, as recyclables data tended to have smaller variability than the discards data.

Figure 16. Waste Generation Rate for Curbside Discards and Recyclables, by District (lbs/HH/wk)
Figure 17. Percentage of Paper in Curbside Set-outs (Discards and Recyclables), by District

Figure 18. Percentage of Containers in Curbside Set-outs (Discards and Recyclables), by District
Figure 19. Curbside Source Separation Percentage, Paper, by District

Figure 20. Curbside Source Separation Percentage, Containers, by District
Figure 21. Source Separation Percentage for Recyclable Aluminum

Figure 22. Source Separation Percentage for #1 and #2 Plastic Containers
4. Discussion

4.1. Distinctions among the Districts

District 1 generates less waste per household than the two other districts. District 1 source separates a greater amount of waste than the two other districts, and therefore has a greater source separation percentage, considering only paper and containers collections as well as total source separation including yard wastes. District 1 separates paper, container, and yard wastes more efficiently than the two other districts do, considering each material and its generation rate in each district. District 1 generates greater amounts of paper recyclables and glass containers to manage than the other two districts. Because it generates recyclable materials at this higher rate, the percentage of recyclables in the discards is greatest for District 1 (the rate per household is not, however).

Except in comparison to yard waste percentages for District 18, District 31 source separates every material worse than the other two districts, both in terms of rates (in lbs/HH/wk) and in terms of percentages of each material available (the rate differences are negligible for ferrous, aluminum and #1 and #2 plastics). District 31 generates container plastics and ferrous at greater rates than the other two districts, and slightly more aluminum, but source separates less of each material.

District 18 had very poor source separation of yard waste during the sampling period. The source separation percentage achieved in District 18 tended to fall midway between the higher source separation percentages achieved in District 1 and the lower percentages found for District 31. Because District 18, although having the greatest overall waste generation rate of the three districts, did not generate paper and container recyclables at as great a rate as District 1, the lower separation percentage resulted in fewer paper and container recyclables being source separated in District 18 compared to District 1 (although these were more than District 31).

4.2. Recyclables Remaining in Discards

It is clear that residents (even in the highest source separation rate district) leave meaningful amounts of recyclables in the discards. Overall source separation rates for the curbside recyclables are on the order of one-quarter for District 31, one-third for District 18, and less than half for District 1. This means that large amounts of the discards are recyclables: more
than one-quarter for Districts 18 and 31, and nearly one-third for District 1. When yard waste is included in the tally, over one-third of all discards are recyclable (40% in District 18). If these rates were consistent across all waste districts and all time periods, one implication is that the Town is spending more than $5 million on transport and disposal of materials that might actually have a positive value if processed through the MRF, and at least $250,000 on yard wastes that could be managed for much less through the Town’s composting vendor.

More valuable materials sometimes have lower recovery rates. Although the amounts varied a lot among the 17 samples from each district, it seems likely that about 20% of recyclable aluminum is being recovered and 30% of recyclable #1 and #2 plastic containers are being recovered (note that these data only reflect comparisons between materials set out for recovery and those left in the waste stream, and do not account for diversions to the State nickel deposit program). The percentages are lower in District 31. Aluminum and HDPE and PET plastics consistently return more per pound from markets when recovered than other materials. Each ton in the waste stream not only costs the Town for disposal (~$100) but the Town also loses its share of the $500+ value associated with these materials in the secondary market. The 2.5-3 lbs of aluminum and #1 & #2 plastic containers disposed by the typical household in these three districts each week costs the Town circa $50/yr for each household in additional disposal fees and foregone MRF profits.

4.3. Yard Waste

We were surprised to sample so much yard waste in the discards samples. Even the best source separation district (District 1) left over one-quarter of generated yard waste in the discards during the sampling period. We surprised at this result because an earlier analysis conducted for the SWMP update found negligible seasonal differences in the Town-wide disposal rate. We assumed this meant that the most seasonal waste was being effectively source separated, as otherwise we thought the waste stream would show notable seasonal waste fluctuations. Yard waste was measured in 38 of 51 samples (~75%), although if smaller sample amounts (2 lbs or so) are discounted, only about two-thirds of all samples contained larger amounts of yard waste.

There were some correlations between yard waste collections and sampling events with no yard waste. For instance, there were eight sampling events in District 1 where there were negligible amounts of yard waste. For one sample there was a yard waste collection (September
10) on the same day. Over the time period in October where no yard waste was observed in all six samples, there were two collection events. There were only three samples from District 18 with no or little yard waste; one was the Monday after a Friday yard waste collection and one was the same day as a yard waste collection day. Yard wastes were collected the Thursday after a Monday August 20 sample where no yard waste was recorded, and on a Wednesday after another Monday (September 24) where there was only a small amount of yard wastes were found, in District 31. One implication is that some of the yard waste in the discards may have resulted from carters taking yard waste with discards intentionally, although they had been set out for separate collection, due to the concurrence of no yard waste in discards and yard waste collections. Absent actual observation of such events, however, the analysis remains speculative (and not entirely persuasive).

Generally yard waste separation rates for the sampling period were less than those computed for the districts on annual basis. District 1 separated 6.1 lbs/HH/wk during the sampling period, but averaged 14.1 lbs/HH/wk in 2011; similarly, District 18 separated 4.0 lbs/HH/wk in the sampling period, and 17.4 lbs/HH/wk in 2011, and District 31 separated 3.7 lbs/HH/wk during the sampling period, and 12.4 lbs/HH/wk in 2011. This is partially due to more yard waste being generated at other times of the year (such as spring clean-up time, early summer grass clipping maxima – although these are not supposed to be collected – and later fall leaf set-outs), but also due to the poor separation rates, especially in Districts 18 and 31.

Although separate yard waste management is a cost to the Town, the cost is less than the haul and discard fees for discards, by approximately $40/ton. It is difficult to project overall additional costs for improper management of yard wastes, as the separation percentages for the three districts varied widely, and it is difficult to think that during peak yard waste generation times that the same source separation rates hold (we assume the source separation rates for fall leaves is very high, for instance). Still, over the course of the year even out-of-season misallocation of yard wastes would result in considerably higher disposal costs for the Town. It could be as much as $250,000.

4.4. Overall Concordance with Town Waste Rules

The maximum recovery rates for the Town’s program could be between 40% and 50% (assuming all yard waste is removed from the waste stream), but instead are much lower. This is
because even the best source separation district puts half of all potentially recyclable material in
the discards. Poorer source separation districts have even worse compliance with the Town’s
source separation codes. In the 25th year of the curbside program, with universal annual mailings
and other public outreach efforts, it is not very credible to assert that general ignorance is the
primary cause for this failure to comply. Instead, it appears that many residents are choosing not
to (fully) comply with Town recycling rules.

The MRF discards ~15% of all delivered materials each year, almost all of which is
generated on the container side (this implies that only about half of the materials delivered as
source-separated containers go to market). Our sampling of source-separated container materials
found only about 15% of the material was not designated materials. Much of this 15% non-
compliant materials were things that the operator currently finds markets for, such as small
appliances and, especially, other rigid plastics. This implies that the reject-residual issue at the
MRF is a process problem, not one of Town residents delivering too much in the way of
inappropriate materials.

4.5. Implications for Single Stream Recycling

Our initial, informal analysis of the data sets suggested that the percentage of recyclable
containers (or recyclable paper) in the discards decreased on the Thursday collection day
following Wednesday recyclables collection of containers (or papers). This suggested that
recyclables disposal might have been decreased because homeowners were reminded to recycle
(and had the need to recycle re-enforced) by setting out recyclables. It could also be that the
convenience and/or opportunity of having an empty bin to store the recyclables enhanced
recyclables recovery. Note that Bill Rathje suggested that wastes will be accumulated
proportional to the container available to store them in; thus, an empty container is an invitation
to place materials in it, and a full container is a deterrent. If any of these notions were to hold in
the Town of Brookhaven, it would support the prospect of increased recyclables recovery with
implementation of single-stream recycling, based on weekly collection of both paper and
containers.

Unfortunately, more careful examination of the data finds no pattern supporting the initial
claim. In Figures 23-30, we show the rate of recyclables in discards (in lbs/HH/wk) or
percentage of recyclables in discards with reference to the recyclables collection days. The x-
axis lines indicate the Wednesdays when the particular set of recyclables was collected, and the
graph shows trends in the data, before and after the recyclables collection. Two general
conditions need to be checked for:

1) the recyclables in discards show either an increase on the second discard collection day
   in a period or a generally increasing trend across the collection day;

2) a decrease in recyclables for the two points across the collection marker.

Either of these would indicate support for the idea that there pre-exists evidence that single-
stream recycling will enhance recyclables collection (or, at least, decrease recyclables in the
discards). There are some occurrences of both conditions. However, just as many times the
opposite occurs. Therefore, it is not possible to cite these data as providing evidence that single-
stream recycling is likely to improve recycling in the Town.

These graphs also do not show noticeable increases in the disposal rate or percentage of
containers in discards on the collection day after Labor Day (September 6) or Columbus Day
(October 11), as might be expected if backyard barbeques disrupted normal disposal patterns.
Figure 23. District 1 (○) Paper Discards (lbs/HH/wk) (vertical lines indicate paper recyclables collection days)

Figure 24. District 1 (○) Paper as a Percentage of Discards (vertical lines indicate paper recyclables collection days)
Figure 25. District 18 (+) and District 31 (x) Paper Discards (vertical lines indicate paper recyclables collection days)

Figure 26. District 18 (+) and District 31 (x) Paper as a Percentage of Discards (lbs/HH/wk) (vertical lines indicate paper recyclables collection days)
Figure 27. District 1 (○) Container Discards (lbs/HH/wk) (vertical lines indicate container recyclables collection days)

Figure 28. District 1 (○) Containers as a Percentage of Discards (vertical lines indicate container recyclables collection days)
4.6. Food Waste

Food waste recovery is touted as a means to increase recycling rates in places where rates have stalled, such as the Town. The New York State SWMP emphasizes the role of expansion of recovery programs to include food, as part of the Plan’s goal to diminish discards across the State. Food waste recovery would either require a separate collection, or collection through an
enhanced “yard waste-organics” program, which could replace a discards collection if diversion rates were high enough.

Food waste accounted for ~12% of wastes across the three districts. If recovery rates were similar to the container portion of the curbside program, then between 25% and 50% of the material should be diverted. The median recycling district recovers one-third of available containers, so that would seem to be a reasonable estimate for the potential effectiveness of source-separating food waste. Recovering one-third of food waste implies another 4% or so of the Town’s waste stream could be diverted (~6,000 to 9,000 tons per year, Town-wide). Using a nominal $100 transfer and disposal cost value for discards, that suggests an upper bound on program costs savings might be ~$1 million. However, food waste separation might require additional collection efforts (and so, additional collection costs), and unlike curbside recyclables, food waste does not have market value. Current disposal costs for yard wastes are ~$60/ton, suggesting at least half of potential savings will be spent on disposal of the separated materials, assuming food waste can be managed at the same cost as yard wastes. If source separation rates are less than 50%, it may be difficult to reduce discards collections, especially during summer months when odors and other garbage issues (leachates, maggots) are greater. Differential collection rates (fewer discards collection days in winter, more in warmer times) are a technical solution, but may have implementation problems due to reliance of many residents on habit to determine garbage set-outs. This suggests the economics and associated practical details of food waste recovery may not be favorable.
4.7. Textiles

We did not specially separate textiles. They were included in the organic fraction of wastes. However, a number of samples contained large quantities of textiles, apparently from closet emptying. Many of these clothes were in “like-new” condition.

4.8. Electronics

Electronics receive a great deal of attention. We also included small appliances in our electronics category, so the separation designated as electronics contains fewer electronic gadgets than the category title suggests. There were no large electronic devices disposed during the sampling (for that matter, there were no white goods or bulky wastes such as mattresses or furniture, and we did not include any large rugs in our sampling). This is partially because they did not fit well into the bucket loader. It also suggests they may not be common in the discards. The electronic category comprised less than 0.5 lbs/HH/wk in all districts (less than 25 lbs/HH/yr).
THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK
5. Findings

- Town residents source separate recoverable materials poorly. Even the best source separation district leaves about half of its recyclable materials in discards, and districts where recovery percentages are lower do worse than that. This failure costs the Town millions of dollars (in foregone recyclables revenues, unnecessary transfer and disposal fees, and the potential for reduced costs managing yard wastes through composting rather than incineration).

- Better recycling percentages are correlated with better source separation percentages, but also with greater amounts of recyclable materials on hand. That is, the better recovery district not only complied better with Town rules, but generated more recyclable materials (especially paper and glass) to apply these recovery processes to.

- Town residents do not set out overly-contaminated container recyclables.

- The yard waste disposal ban is not as effective as it appears to be. Carter behavior may play a role in this.

- Current compliance with source separation rules suggest that food waste source separation will not recover most of the relatively large amounts of food waste currently disposed in the Town. The economic feasibility of separate food waste collection, in light of residents’ current recycling behaviors, should be carefully examined if such a program is considered.

- There are no trends or patterns in existing source separation data to suggest single-stream recycling will generate significantly greater amounts of recyclables compared to the existing program. It is clear that room for great improvement in the performance of the recycling program exists, however.

- RecycleBank does not seem to be changing residents’ behavior, based on our comparison of 2011 and 2012 recovery data for the three districts we examined.

- Higher source separation rates are mildly associated with lower overall waste generation rates. This was clearly the case when comparing District 1 to Districts 18 and 31, although since the districts were chosen and not randomly selected the comparison does not mean very much. However, Figure 32 shows a trend line for all Town waste districts (except for District 32 which was excluded for anomalously high waste generation rates,
probably due to exclusion of households from the district count after the Village of Mastic Beach was formed), which illustrates this concept.

This suggests that different recycling behaviors are associated with different waste generation patterns, both in terms of composition of wastes and the rates at which wastes are generated. The data collected here suggest that better recyclers not only source separate better, but they have recyclables-enriched waste streams (more paper and glass) which constitute a greater proportion of all wastes that they generate.

Figure 32. 2011 Trend for District Waste Generation Rates and Recycling Percentages
6. **Recommendations**

The current Town recycling program separates more than 25,000 tons of paper and containers and more than 35,000 tons of yard waste from the Town waste stream, which are not negligible amounts of materials. However, this appears to be less than half of the potential recovery rates.

If greater recovery rates are important to the Town, perhaps a change in course is needed. It may be that rolling out single-stream recycling, with attendant publicity, will energize residents and re-inspire their participation in the source separation program. It may be that much of the material is left in discards because residents do not know these materials should be source separated. It may be that other positive incentives may be useful at increasing participation in the program.

However, it is also clear that compliance with Town Code for some materials is very poor, and generally poorer source separation districts do not follow rules well at all. In many governmental settings this would seem to suggest that enforcement efforts are in order, if compliance is deemed to be in the public interest. Certainly greater use of the non-punitive carter sticker program should be considered, but it may be that a high visibility ticket program could also impact behavior. New York City (selectively) enforces its source separation program, and appears to achieve better source separation percentages than the Town does (New York City reports source separation rates in the vicinity of 20% for paper and container recyclables). There seems to be little political fallout from this program, as well, although such politics are very different in New York City compared to the Town.
Appendix A. Statistical Analysis – PERMANOVA

Statistically significance of similarity (or dissimilarity) in waste composition among the sampled districts was tested using non-parametric statistical methods - PERMANOVA (Permutation-based Multivariate Analysis of Variance) (Anderson, 2005) with PERMDISP (Permutation-based Analysis of Multivariate Dispersions) (Anderson, 2004).

The composition of MSW does not necessarily follow a normal distribution (Sfeir et al., 1999). The component distribution has been reported to skew positively, or in extreme cases, follow a J-shaped distribution. The non-adherence to the discrete normal distribution has been attributed to the diversity of material composition and their varying dimensions (Klee, 1993). The traditional Multivariate Analysis of Variance (MANOVA) test relies on the assumption that the dataset subjected to testing conforms to multivariate normal distribution (Sokal and Rohlf, 1995, p. 423; Neave and Worthington, 1992).

For these reasons, the Permutation-based Non-Parametric Multivariate Analysis of Variance, a.k.a. PERMANOVA (Anderson, 2005) was used for the analysis. PERMANOVA is a non-parametric statistical test used to test differences within groups based on pre-selected distance measures. This test does not need multivariate normality (Anderson, 2001). The test requires multivariate homogeneity of variance that is tested using the PERMDISP (Permutation-based Dispersion of Variance) test (Anderson, 2004).

In PERMANOVA, the test statistic is the inter-point distances between each variable of each replicate sample of all the groups of each factor (Figure A-1). The within-group and between-group distances are calculated from a distance matrix that defines the inter-point distances. The distance matrix is derived from the original dataset containing variables as columns and factors as rows; the present study only had one factor (waste districts). Each factor has more than one group, three waste districts in the present case, with multiple sample replicates, 17 samples here, listed row-wise.
PERMANOVA tests the null hypothesis that there is no difference between groups, as will be reflected by the group-based inter-point distances (between-group variance). It calculates the variance similar to traditional ANOVA. The total sum of square, SST, is the average of all the inter-point distances relative to the total sample size. The within-group sum of squares, SSW, is the average inter-point distances of a particular group relative to the number of sample units in that group. The between-group sum of square, SSB is the difference between SST and SSW. The test generates an $F$-statistic, similar to the one that is generated in a parametric ANOVA, which can be used to compare within-group and between-group variability. The $F$-ratio is calculated as follows:

$$F = \frac{SSB / (a-1)}{SSW / (N-a)}$$

where,

- $N =$ total sample size,
- $a =$ number of groups,
- $SSB =$ between-group sum of square,
- $SSW =$ within-group sum of squares.
If the multi-variate observations in different groups have different centroids, then the between-group distance will be relatively large compared to within-group distance resulting into a higher $F$-ratio.

In absence of a pre-selected distribution to conform to, PERMANOVA generates a $p$-distribution using permutations of replicate samples. This is done by assuming that the $H_0$ holds true, essentially meaning that there is no difference between replicate samples of each group. In the present study, this would mean that the membership in a particular waste district will not control the configuration of the component waste and recyclables categories that define the recycling performance indicators. In such a case, the rows of the original dataset can be said to be exchangeable, i.e., replicate sample from the three waste districts can be randomly shuffled. For example, sample 14 from District 1 can be exchanged with sample 9 from District 31 or sample 3 from District 18 can be substituted by sample 15 from District 31; such exchanges will not affect the differences between groups (because the $H_0$ holds true).

Large numbers of such permutations are possible; typically, at least 1,000 and 5,000 permutations are recommended in PERMANOVA, for data sets that can be tested at significance levels of 0.05 and 0.01 respectively. An $F$-value is calculated for each permutation, and is designated as “$F^\pi$” indicating that it is a pseudo-$F$-value, i.e. not derived from the original permutation of replicate samples. The critical value, $P$, is obtained by comparing the original $F$-value to the $F^\pi$s. The $p$-value is calculated as follows,

$$p = \frac{\text{No. of } F^\pi \geq F}{\text{Total no. of } F^\pi}$$

………… (Eq. 2)

PERMANOVA can be used for single or multi-factor experimental designs. The present experiment was a one-way analysis because it was hypothesized that the any likely differences in the recycling performance measures and their factor components was due to their membership to any particular waste district, either Districts 1, 18, or 31.

If PERMANOVA results suggest significant differences in groups, additional pair-wise, a posteriori tests can be used to explore distance between pairs of groups. This test generates a $t$-
statistic, with the magnitude (t-value) and statistical significance (p-value), indicating which of the group-pairs differs.

PERMANOVA assumes homogeneity of error-variances, i.e. that the errors are random, and are independent and identically distributed. A supplementary test called Permutational Analysis of Multivariate Dispersions (PERMDISP) was performed before PERMANOVA to compare the multi-variate dispersions between different groups based on selected distance measure. PERMDISP tests the null hypothesis that there is no difference in multi-variate dispersions among groups. The conceptual foundation of the test overlaps with PERMANOVA such that the dispersions in each individual group are calculated with respect to the replicate observation in that group and the group’s inter-point distances in a multi-variate space. The average dispersions, calculated for each permutational arrangement of the rows (assuming exchangeability under the null hypothesis) are then compared using the F-ratio (as calculated in equation 2) against a p-value selected a priori.

Both tests, PERMANOVA and PERMDISP, can be performed using a variety of distance measures, such as Euclidean distance, Bray-Curtis dissimilarity, Chi-square distance, and Manhattan (City Block) distance. Standard transformations, such as square-root, logarithmic, or inverse function, can be performed on the original dataset. The choice of distance measure, as well as that of transformations, may affect the outcome of the test (Anderson, 2005). The present analyses were performed using Euclidean distance measure. No transformation was applied to the data before the analyses. 9,999 permutations were used to create critical values.
<table>
<thead>
<tr>
<th>Combination</th>
<th>$F$</th>
<th>$p$</th>
<th>1,18</th>
<th>1,31</th>
<th>18,31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Paper in Discards</td>
<td>1.734</td>
<td>0.1879</td>
<td>1.6667</td>
<td>0.6095</td>
<td>1.2428</td>
</tr>
<tr>
<td>Containers in Discards</td>
<td>0.759</td>
<td>0.4944</td>
<td>1.0797</td>
<td>0.124</td>
<td>0.9903</td>
</tr>
<tr>
<td>Discarded paper and containers, considered as two variables</td>
<td>2.3771</td>
<td>0.1045</td>
<td>1.9483</td>
<td>0.5353</td>
<td>1.5164</td>
</tr>
<tr>
<td>All discarded recyclables</td>
<td>1.9947</td>
<td>0.1438</td>
<td>1.8289</td>
<td>0.473</td>
<td>1.3676</td>
</tr>
<tr>
<td>Source separated Total Paper</td>
<td>3.9047</td>
<td><strong>0.0263</strong></td>
<td>1.833</td>
<td>2.4198*</td>
<td>1.0224</td>
</tr>
<tr>
<td>Source-separated Container Recyclables</td>
<td>5.1261</td>
<td><strong>0.0097</strong></td>
<td>2.8324**</td>
<td>0.7024</td>
<td>2.1454*</td>
</tr>
<tr>
<td>Source separated paper and containers, considered as two variables</td>
<td>2.4413</td>
<td>0.1034</td>
<td>0.5393</td>
<td>2.1861</td>
<td>1.9266</td>
</tr>
<tr>
<td>All source separated recyclables</td>
<td>0.6713</td>
<td>0.5227</td>
<td>0.189</td>
<td>0.9544</td>
<td>1</td>
</tr>
<tr>
<td>Waste generation Total Paper</td>
<td>1.4155</td>
<td>0.2527</td>
<td>1.4335</td>
<td>0.2973</td>
<td>1.2935</td>
</tr>
<tr>
<td>Waste generation, Recyclable Containers</td>
<td>0.55</td>
<td>0.5972</td>
<td>0.9978</td>
<td>0.3411</td>
<td>0.6526</td>
</tr>
<tr>
<td>Waste generation, paper and containers, considered as two variables</td>
<td>2.0934</td>
<td>0.1351</td>
<td>1.7923</td>
<td>0.4179</td>
<td>1.5048</td>
</tr>
<tr>
<td>Waste generation, all recyclables</td>
<td>2.0444</td>
<td>0.137</td>
<td>1.842</td>
<td>0.5122</td>
<td>1.3892</td>
</tr>
<tr>
<td>Discarded non-recyclables</td>
<td>7.4863</td>
<td><strong>0.0009</strong></td>
<td>2.8239**</td>
<td>0.2238</td>
<td>3.3948**</td>
</tr>
<tr>
<td>Total waste generation</td>
<td>5.2924</td>
<td><strong>0.0081</strong></td>
<td>3.0529**</td>
<td>1.7483</td>
<td>1.6313</td>
</tr>
<tr>
<td>Source separation percentage</td>
<td>0.7988</td>
<td>0.4585</td>
<td>0.5272</td>
<td>1.2171</td>
<td>0.825</td>
</tr>
</tbody>
</table>

Table A-1: PERMDISP Results (bold indicates a significant result for three districts, and * = significance at $p < 0.05$ and ** = significance at $p < 0.01$ for pair-wise comparisons)

<table>
<thead>
<tr>
<th>Combination</th>
<th>$F$</th>
<th>$p$</th>
<th>1,18</th>
<th>1,31</th>
<th>18,31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Paper in Discards</td>
<td>0.2024</td>
<td>0.8126</td>
<td>0.6057</td>
<td>0.2981</td>
<td>0.3483</td>
</tr>
<tr>
<td>Containers in Discards</td>
<td>0.9912</td>
<td>0.3847</td>
<td>0.6792</td>
<td>1.6632</td>
<td>0.6399</td>
</tr>
<tr>
<td>Discarded paper and containers, considered as two variables</td>
<td>0.4033</td>
<td>0.777</td>
<td>0.6252</td>
<td>0.8552</td>
<td>0.4447</td>
</tr>
<tr>
<td>All discarded recyclables</td>
<td>0.4971</td>
<td>0.6089</td>
<td>0.8088</td>
<td>1.0453</td>
<td>0.0285</td>
</tr>
<tr>
<td>Source separated Total Paper</td>
<td>1063.704</td>
<td>(0.0001)</td>
<td>21.4823**</td>
<td>(42.8249)**</td>
<td>28.2416**</td>
</tr>
<tr>
<td>Source-separated Container Recyclables</td>
<td>146.2902</td>
<td>(0.0001)</td>
<td>(10.5553)**</td>
<td>22.1657**</td>
<td>(4.8121)**</td>
</tr>
<tr>
<td>Source separated paper and containers, considered as two variables</td>
<td>539.9005</td>
<td><strong>0.0001</strong></td>
<td>16.2843**</td>
<td>36.0640**</td>
<td>15.3340**</td>
</tr>
<tr>
<td>All source separated recyclables</td>
<td>927.6093</td>
<td><strong>0.0001</strong></td>
<td>23.3195**</td>
<td>44.1897**</td>
<td>19.0165**</td>
</tr>
<tr>
<td>Waste generation Total Paper</td>
<td>4.5794</td>
<td><strong>0.0157</strong></td>
<td>0.9718</td>
<td>3.3413**</td>
<td>1.8661</td>
</tr>
<tr>
<td>Waste generation, Recyclable Containers</td>
<td>0.5386</td>
<td>0.5971</td>
<td>0.8484</td>
<td>1.0629</td>
<td>0.053</td>
</tr>
<tr>
<td>Waste generation, paper and containers, considered as two variables</td>
<td>3.5669</td>
<td><strong>0.0191</strong></td>
<td>0.9436</td>
<td>2.9552**</td>
<td>1.5986</td>
</tr>
<tr>
<td>Waste generation, all recyclables</td>
<td>4.0377</td>
<td><strong>0.0263</strong></td>
<td>1.17</td>
<td>3.3432**</td>
<td>1.4779</td>
</tr>
<tr>
<td>Discarded non-recyclables</td>
<td>22.7795</td>
<td>(0.0001)</td>
<td>(5.78)**</td>
<td>6.2711**</td>
<td>(20.590)**</td>
</tr>
<tr>
<td>Total waste generation</td>
<td>15.9287</td>
<td>(0.0001)</td>
<td>(5.4136)**</td>
<td>2.8218**</td>
<td>2.9496**</td>
</tr>
<tr>
<td>Source separation percentage</td>
<td>250.6165</td>
<td><strong>0.0001</strong></td>
<td>14.72**</td>
<td>21.2089**</td>
<td>6.1548**</td>
</tr>
</tbody>
</table>

Table A-2. PERMANOVA Results (bold indicates a significant result for three districts, and * = significance at $p < 0.05$ and ** = significance at $p < 0.01$ for pair-wise comparisons) (parentheses indicate a failed PERMDISP test)
Table A-1 shows PERMDISP results for key comparisons. A significant result indicates that PERMANOVA is not an appropriate test for the variables. Significant results were found for the noted variables in Table A-2 under PERMANOVA. Note that some of the PERMANOVA results are not considered valid due to significant findings for PERMDISP.

PERMDISP results found that most descriptors did not have statistically significant dispersion \((p < 0.05)\), except Discarded Non-recyclables \((F = 7.4863, \ p = 0.0009)\), Source-separated Container Recyclables \((F = 5.1267, \ p = 0.0097)\), Source-separated Total Paper \((F = 3.9047, \ p = 0.0263)\), and Total Waste Generation \((F = 5.2924, \ p = 0.0081)\).

Significant differences were found through PERMANOVA for Waste Generation for All Recyclables \((F = 4.0377, \ p = 0.0263)\), Waste Generation for Paper and Containers, considered as two variables \((F = 3.5669, \ p = 0.0191)\), Total Mixed Paper \((F = 4.5794, \ p = 0.0157)\), All Source-separated Recyclables \((F = 927.6093, \ p = 0.0001)\), and Source-separated Paper and Containers, considered as two variables \((F = 539.9005, \ p = 0.0001)\). As expected, differences in Source-separation Percentage were confirmed by the statistical test \((F = 250.6165, \ p = 0.0001)\).

A-priori pair-wise comparisons suggested that the significance of the differences among waste districts for each pair of waste districts was maintained. Some pair-wise comparisons for relationships that were invalidated by PERMDISP were also significant. These included Source-separated Total paper between Districts 1 and 18 and Districts 18 and 31, and Source-separated Container Recyclables between Districts 1 and 31. Non-recyclables in Discards were significantly different between Districts 1 and 31, and Total Waste generation was significantly different between Districts 1 and 31 and Districts 18 and 31.

References:
## Appendix B. Sampling Data

<table>
<thead>
<tr>
<th>Date</th>
<th>Sample</th>
<th>PPR</th>
<th>CC</th>
<th>BGS</th>
<th>TRP</th>
<th>RGD</th>
<th>YRD</th>
<th>FD</th>
<th>WD</th>
<th>ORG</th>
<th>FE</th>
<th>AL</th>
<th>GLS</th>
<th>INORG</th>
<th>ELC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>820</td>
<td>1</td>
<td>26.85</td>
<td>6.05</td>
<td>14</td>
<td>3.1</td>
<td>3</td>
<td>18.25</td>
<td>22.05</td>
<td>36.85</td>
<td>32.85</td>
<td>2.7</td>
<td>0.55</td>
<td>6.7</td>
<td>13.3</td>
<td>0</td>
<td>186.25</td>
</tr>
<tr>
<td>823</td>
<td>2</td>
<td>5.7</td>
<td>16.3</td>
<td>14</td>
<td>2.9</td>
<td>2.8</td>
<td>10.7</td>
<td>23.65</td>
<td>3.15</td>
<td>23.95</td>
<td>4.3</td>
<td>0.9</td>
<td>10.45</td>
<td>0</td>
<td>0</td>
<td>118.8</td>
</tr>
<tr>
<td>827</td>
<td>3</td>
<td>15.6</td>
<td>26.4</td>
<td>6.85</td>
<td>8.6</td>
<td>6.8</td>
<td>19.5</td>
<td>26.35</td>
<td>9.35</td>
<td>39.45</td>
<td>2.65</td>
<td>0.65</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>169.2</td>
</tr>
<tr>
<td>830</td>
<td>4</td>
<td>18.3</td>
<td>13</td>
<td>7</td>
<td>6.3</td>
<td>3.3</td>
<td>9.85</td>
<td>26.35</td>
<td>4.5</td>
<td>39.45</td>
<td>2.85</td>
<td>1.55</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>139.45</td>
</tr>
<tr>
<td>906</td>
<td>5</td>
<td>24.65</td>
<td>6.25</td>
<td>3.5</td>
<td>6.3</td>
<td>3.2</td>
<td>29.45</td>
<td>27.2</td>
<td>7.46</td>
<td>27.7</td>
<td>4</td>
<td>1.15</td>
<td>4.55</td>
<td>0</td>
<td>0</td>
<td>145.41</td>
</tr>
<tr>
<td>910</td>
<td>6</td>
<td>22.85</td>
<td>14.55</td>
<td>2.5</td>
<td>2.25</td>
<td>0.85</td>
<td>0</td>
<td>25.8</td>
<td>21.95</td>
<td>5.15</td>
<td>0.65</td>
<td>2.25</td>
<td>2.85</td>
<td>0</td>
<td>4.3</td>
<td>105.95</td>
</tr>
<tr>
<td>913</td>
<td>7</td>
<td>54.8</td>
<td>15.25</td>
<td>6.55</td>
<td>5.5</td>
<td>8.05</td>
<td>8.05</td>
<td>13.6</td>
<td>28.15</td>
<td>26.4</td>
<td>5.55</td>
<td>9</td>
<td>11.1</td>
<td>13.2</td>
<td>1</td>
<td>206.2</td>
</tr>
<tr>
<td>917</td>
<td>8</td>
<td>38.85</td>
<td>6.9</td>
<td>7.15</td>
<td>5.3</td>
<td>3.5</td>
<td>0</td>
<td>38.9</td>
<td>5.85</td>
<td>18</td>
<td>0.5</td>
<td>0.55</td>
<td>14.25</td>
<td>11.2</td>
<td>1</td>
<td>151.95</td>
</tr>
<tr>
<td>920</td>
<td>9</td>
<td>29.45</td>
<td>11.4</td>
<td>20.95</td>
<td>3.85</td>
<td>4.45</td>
<td>24.1</td>
<td>46.9</td>
<td>8.3</td>
<td>30.05</td>
<td>0.55</td>
<td>1.65</td>
<td>3.4</td>
<td>5.4</td>
<td>0.5</td>
<td>190.95</td>
</tr>
<tr>
<td>924</td>
<td>10</td>
<td>18.8</td>
<td>7.65</td>
<td>10.65</td>
<td>19.4</td>
<td>2.3</td>
<td>27.25</td>
<td>17.65</td>
<td>2.65</td>
<td>32.05</td>
<td>1.75</td>
<td>2.7</td>
<td>2.3</td>
<td>9</td>
<td>5.3</td>
<td>159.45</td>
</tr>
<tr>
<td>927</td>
<td>11</td>
<td>27.6</td>
<td>13.7</td>
<td>7.65</td>
<td>2.5</td>
<td>2.4</td>
<td>8.2</td>
<td>22.85</td>
<td>57.1</td>
<td>26.75</td>
<td>1.45</td>
<td>0.85</td>
<td>1.15</td>
<td>12.1</td>
<td>0</td>
<td>184.3</td>
</tr>
<tr>
<td>1001</td>
<td>12</td>
<td>19.1</td>
<td>12.5</td>
<td>7.65</td>
<td>8.75</td>
<td>17.35</td>
<td>2.2</td>
<td>22.85</td>
<td>8.3</td>
<td>90.8</td>
<td>6.2</td>
<td>1.3</td>
<td>3.5</td>
<td>36.2</td>
<td>0</td>
<td>236.7</td>
</tr>
<tr>
<td>1004</td>
<td>13</td>
<td>23.175</td>
<td>10.45</td>
<td>14.575</td>
<td>7.95</td>
<td>17.325</td>
<td>1.1</td>
<td>22.25</td>
<td>17.725</td>
<td>57.55</td>
<td>4.35</td>
<td>1.3</td>
<td>4.1</td>
<td>22.675</td>
<td>4.51</td>
<td>209.035</td>
</tr>
<tr>
<td>1011</td>
<td>14</td>
<td>27.25</td>
<td>8.4</td>
<td>21.5</td>
<td>7.15</td>
<td>17.3</td>
<td>0</td>
<td>21.65</td>
<td>27.15</td>
<td>24.3</td>
<td>2.5</td>
<td>1.3</td>
<td>4.7</td>
<td>9.15</td>
<td>9.02</td>
<td>181.37</td>
</tr>
<tr>
<td>1015</td>
<td>15</td>
<td>12.15</td>
<td>28.55</td>
<td>9.7</td>
<td>4.2</td>
<td>7.6</td>
<td>0</td>
<td>18.75</td>
<td>3.65</td>
<td>32.9</td>
<td>5.5</td>
<td>1.65</td>
<td>2.35</td>
<td>12.35</td>
<td>4.85</td>
<td>144.2</td>
</tr>
<tr>
<td>1018</td>
<td>16</td>
<td>23.95</td>
<td>9.75</td>
<td>7.45</td>
<td>7.45</td>
<td>3.15</td>
<td>2.2</td>
<td>53.05</td>
<td>1.35</td>
<td>48.65</td>
<td>2.55</td>
<td>0.85</td>
<td>6.5</td>
<td>8.75</td>
<td>0</td>
<td>175.65</td>
</tr>
<tr>
<td>1022</td>
<td>17</td>
<td>17.35</td>
<td>55.3</td>
<td>17.3</td>
<td>5</td>
<td>31</td>
<td>0</td>
<td>15.25</td>
<td>20.65</td>
<td>36.75</td>
<td>1.3</td>
<td>1.5</td>
<td>6.4</td>
<td>5</td>
<td>0</td>
<td>212.8</td>
</tr>
<tr>
<td>1115</td>
<td>18</td>
<td>36.3</td>
<td>14.35</td>
<td>14.15</td>
<td>4.55</td>
<td>3</td>
<td>11.25</td>
<td>62</td>
<td>2</td>
<td>32</td>
<td>1.6</td>
<td>1.5</td>
<td>1</td>
<td>9.5</td>
<td>0</td>
<td>193.2</td>
</tr>
</tbody>
</table>

PPR = recyclable paper, CC = corrugated cardboard, BGS = plastic film, TRP = #1 and #2 plastic containers, RGD = rigid plastics, YRD = yard waste, FD = food waste, WD = wood, ORG = other organics, FE = ferrous containers, AL = aluminum containers, GLS = glass containers, INORG = other inorganics, ELC = electronics.

Table B-1: Net Weight of Materials Sampled from District 1
<table>
<thead>
<tr>
<th>Date</th>
<th>Sample</th>
<th>PPR</th>
<th>CC</th>
<th>BGS</th>
<th>TRP</th>
<th>RGD</th>
<th>YRD</th>
<th>FD</th>
<th>WD</th>
<th>ORG</th>
<th>FE</th>
<th>AL</th>
<th>GLS</th>
<th>INORG</th>
<th>ELC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>820</td>
<td>1</td>
<td>11.15</td>
<td>13.1</td>
<td>12.3</td>
<td>3.9</td>
<td>3.1</td>
<td>11.2</td>
<td>27.7</td>
<td>6.2</td>
<td>64.15</td>
<td>2.2</td>
<td>0.65</td>
<td>3.15</td>
<td>3.75</td>
<td>0</td>
<td>162.55</td>
</tr>
<tr>
<td>823</td>
<td>2</td>
<td>17.25</td>
<td>16.8</td>
<td>8.65</td>
<td>3.5</td>
<td>4.65</td>
<td>24.25</td>
<td>32.2</td>
<td>9.5</td>
<td>31.5</td>
<td>3.25</td>
<td>1.65</td>
<td>6.85</td>
<td>0</td>
<td>0</td>
<td>160.05</td>
</tr>
<tr>
<td>827</td>
<td>3</td>
<td>26.25</td>
<td>12.7</td>
<td>8.05</td>
<td>4.25</td>
<td>3.45</td>
<td>0</td>
<td>21.4</td>
<td>0</td>
<td>78.75</td>
<td>3.85</td>
<td>1.7</td>
<td>1.3</td>
<td>10.2</td>
<td>0</td>
<td>171.9</td>
</tr>
<tr>
<td>830</td>
<td>4</td>
<td>10.05</td>
<td>15.4</td>
<td>17.1</td>
<td>6.1</td>
<td>2.45</td>
<td>30.65</td>
<td>27.65</td>
<td>16.05</td>
<td>32.3</td>
<td>0.8</td>
<td>1.65</td>
<td>9.35</td>
<td>8.25</td>
<td>1.3</td>
<td>179.1</td>
</tr>
<tr>
<td>906</td>
<td>5</td>
<td>13.01</td>
<td>11</td>
<td>6.1</td>
<td>4.95</td>
<td>7.85</td>
<td>20.25</td>
<td>28.4</td>
<td>4.6</td>
<td>33.05</td>
<td>2.1</td>
<td>2.65</td>
<td>3.1</td>
<td>19.45</td>
<td>1.8</td>
<td>158.31</td>
</tr>
<tr>
<td>910</td>
<td>6</td>
<td>29.55</td>
<td>18</td>
<td>1.5</td>
<td>1.25</td>
<td>3.2</td>
<td>37.55</td>
<td>10.95</td>
<td>26.1</td>
<td>34.9</td>
<td>3.05</td>
<td>0.8</td>
<td>2.1</td>
<td>53.6</td>
<td>1</td>
<td>223.55</td>
</tr>
<tr>
<td>913</td>
<td>7</td>
<td>10.15</td>
<td>14.5</td>
<td>3.75</td>
<td>3.5</td>
<td>5.15</td>
<td>19</td>
<td>5.7</td>
<td>5.8</td>
<td>39.7</td>
<td>7.5</td>
<td>1.3</td>
<td>2.95</td>
<td>4.95</td>
<td>0</td>
<td>123.95</td>
</tr>
<tr>
<td>917</td>
<td>8</td>
<td>18</td>
<td>11</td>
<td>9.95</td>
<td>3.65</td>
<td>56.8</td>
<td>76.5</td>
<td>13.4</td>
<td>34.4</td>
<td>80.55</td>
<td>4.95</td>
<td>1</td>
<td>3.25</td>
<td>13.55</td>
<td>0</td>
<td>327</td>
</tr>
<tr>
<td>920</td>
<td>9</td>
<td>29.3</td>
<td>1.4</td>
<td>29.3</td>
<td>2.85</td>
<td>10</td>
<td>100.05</td>
<td>23.95</td>
<td>10.8</td>
<td>49</td>
<td>2.75</td>
<td>0.85</td>
<td>1</td>
<td>30.4</td>
<td>0</td>
<td>291.65</td>
</tr>
<tr>
<td>924</td>
<td>10</td>
<td>16</td>
<td>1.75</td>
<td>14.15</td>
<td>3.9</td>
<td>23.9</td>
<td>18.25</td>
<td>12.6</td>
<td>20.35</td>
<td>48.3</td>
<td>2.05</td>
<td>1.3</td>
<td>1.5</td>
<td>4.95</td>
<td>0</td>
<td>169</td>
</tr>
<tr>
<td>927</td>
<td>11</td>
<td>22.2</td>
<td>15.4</td>
<td>11.5</td>
<td>5.95</td>
<td>3.4</td>
<td>65.45</td>
<td>24.9</td>
<td>11.9</td>
<td>32.35</td>
<td>4.6</td>
<td>0.65</td>
<td>0.85</td>
<td>1.8</td>
<td>200.95</td>
<td></td>
</tr>
<tr>
<td>1001</td>
<td>12</td>
<td>33.25</td>
<td>12.4</td>
<td>11.3</td>
<td>23.95</td>
<td>2.55</td>
<td>3.2</td>
<td>16.2</td>
<td>4.3</td>
<td>62</td>
<td>2.65</td>
<td>2.3</td>
<td>10.05</td>
<td>7.65</td>
<td>3.65</td>
<td>195.45</td>
</tr>
<tr>
<td>1004</td>
<td>13</td>
<td>26.05</td>
<td>4.65</td>
<td>20.65</td>
<td>6.85</td>
<td>14.4</td>
<td>66.4</td>
<td>23.5</td>
<td>3.7</td>
<td>35.3</td>
<td>9.05</td>
<td>2.5</td>
<td>4.85</td>
<td>2.85</td>
<td>2.75</td>
<td>223.5</td>
</tr>
<tr>
<td>1011</td>
<td>14</td>
<td>12.5</td>
<td>6.4</td>
<td>19.45</td>
<td>6.1</td>
<td>26.7</td>
<td>0</td>
<td>19.65</td>
<td>4.85</td>
<td>66.05</td>
<td>8.4</td>
<td>4.45</td>
<td>4.5</td>
<td>18.75</td>
<td>0</td>
<td>197.8</td>
</tr>
<tr>
<td>1015</td>
<td>15</td>
<td>32.35</td>
<td>34.65</td>
<td>11.4</td>
<td>5.3</td>
<td>12.05</td>
<td>18.95</td>
<td>16.35</td>
<td>9.05</td>
<td>48.1</td>
<td>5.75</td>
<td>3.55</td>
<td>1.9</td>
<td>0</td>
<td>3.55</td>
<td>202.95</td>
</tr>
<tr>
<td>1018</td>
<td>16</td>
<td>53.5</td>
<td>50.7</td>
<td>13.35</td>
<td>19.05</td>
<td>13.9</td>
<td>0.5</td>
<td>37.4</td>
<td>5.5</td>
<td>68.7</td>
<td>6.7</td>
<td>1.45</td>
<td>11.05</td>
<td>27.55</td>
<td>0</td>
<td>309.35</td>
</tr>
<tr>
<td>1022</td>
<td>17</td>
<td>33.45</td>
<td>14.25</td>
<td>13.7</td>
<td>4.65</td>
<td>6.5</td>
<td>1</td>
<td>29.9</td>
<td>6.4</td>
<td>21.65</td>
<td>2.1</td>
<td>1.35</td>
<td>1.3</td>
<td>13.8</td>
<td>0</td>
<td>150.05</td>
</tr>
<tr>
<td>1115</td>
<td>18</td>
<td>33.65</td>
<td>14.35</td>
<td>13.15</td>
<td>4.45</td>
<td>4.1</td>
<td>35.95</td>
<td>29.9</td>
<td>59.65</td>
<td>33.55</td>
<td>3.5</td>
<td>1.05</td>
<td>3.65</td>
<td>47.85</td>
<td>17</td>
<td>301.8</td>
</tr>
</tbody>
</table>

PPR = recyclable paper, CC = corrugated cardboard, BGS = plastic film, TRP = #1 and #2 plastic containers, RGD = rigid plastics, YRD = yard waste, FD = food waste, WD = wood, ORG = other organics, FE = ferrous containers, AL = aluminum containers, GLS = glass containers, INORG = other inorganics, ELC = electronics

Table B-2: Net Weight of Materials Sampled from District 18
<table>
<thead>
<tr>
<th>Date</th>
<th>Sample</th>
<th>PPR</th>
<th>CC</th>
<th>BGS</th>
<th>TRP</th>
<th>RGD</th>
<th>YRD</th>
<th>FD</th>
<th>WD</th>
<th>ORG</th>
<th>FE</th>
<th>AL</th>
<th>GLS</th>
<th>INORG</th>
<th>ELC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>820</td>
<td>1</td>
<td>9.4</td>
<td>15.95</td>
<td>10.35</td>
<td>6.15</td>
<td>7.3</td>
<td>0</td>
<td>25.55</td>
<td>8.45</td>
<td>31.3</td>
<td>2.35</td>
<td>1.7</td>
<td>3.5</td>
<td>2</td>
<td>1</td>
<td>125</td>
</tr>
<tr>
<td>823</td>
<td>2</td>
<td>13.05</td>
<td>6.75</td>
<td>18.1</td>
<td>4.2</td>
<td>2.85</td>
<td>14.1</td>
<td>27.75</td>
<td>26.1</td>
<td>41.85</td>
<td>7.15</td>
<td>1.7</td>
<td>4.2</td>
<td>3.5</td>
<td>0</td>
<td>171.3</td>
</tr>
<tr>
<td>827</td>
<td>3</td>
<td>22.8</td>
<td>19.05</td>
<td>13.5</td>
<td>9.75</td>
<td>1.9</td>
<td>34.6</td>
<td>29.05</td>
<td>22.9</td>
<td>30.65</td>
<td>3</td>
<td>2.75</td>
<td>2.15</td>
<td>3.1</td>
<td>0</td>
<td>195.2</td>
</tr>
<tr>
<td>830</td>
<td>4</td>
<td>21.55</td>
<td>20.7</td>
<td>5.2</td>
<td>2.85</td>
<td>2.45</td>
<td>15.6</td>
<td>19.65</td>
<td>13.1</td>
<td>28.95</td>
<td>1.5</td>
<td>1.3</td>
<td>4.7</td>
<td>19.8</td>
<td>0</td>
<td>157.35</td>
</tr>
<tr>
<td>906</td>
<td>5</td>
<td>23.35</td>
<td>11.55</td>
<td>6.25</td>
<td>8.5</td>
<td>1.95</td>
<td>0</td>
<td>26.35</td>
<td>11.35</td>
<td>39.45</td>
<td>1.7</td>
<td>1.95</td>
<td>2.5</td>
<td>6.1</td>
<td>0</td>
<td>141</td>
</tr>
<tr>
<td>910</td>
<td>6</td>
<td>32.9</td>
<td>9.05</td>
<td>15.6</td>
<td>15.55</td>
<td>7.25</td>
<td>40.1</td>
<td>23.35</td>
<td>6.15</td>
<td>11.2</td>
<td>2.55</td>
<td>1.2</td>
<td>14.5</td>
<td>7.25</td>
<td>3</td>
<td>189.45</td>
</tr>
<tr>
<td>913</td>
<td>7</td>
<td>12.5</td>
<td>10.15</td>
<td>3.1</td>
<td>2.85</td>
<td>13</td>
<td>66.95</td>
<td>20.5</td>
<td>20.6</td>
<td>58.9</td>
<td>20.05</td>
<td>2.45</td>
<td>5.75</td>
<td>9.95</td>
<td>0</td>
<td>246.75</td>
</tr>
<tr>
<td>917</td>
<td>8</td>
<td>37.85</td>
<td>9.4</td>
<td>20.85</td>
<td>6.95</td>
<td>17.3</td>
<td>43.35</td>
<td>14.95</td>
<td>15.65</td>
<td>32.35</td>
<td>3.4</td>
<td>1.2</td>
<td>4.05</td>
<td>18.4</td>
<td>0</td>
<td>225.7</td>
</tr>
<tr>
<td>920</td>
<td>9</td>
<td>27.95</td>
<td>8.05</td>
<td>26.85</td>
<td>9.9</td>
<td>0</td>
<td>46.25</td>
<td>7.2</td>
<td>85.7</td>
<td>5.1</td>
<td>0.5</td>
<td>0.45</td>
<td>5.15</td>
<td>0</td>
<td>223.1</td>
<td></td>
</tr>
<tr>
<td>924</td>
<td>10</td>
<td>23.1</td>
<td>13.9</td>
<td>26.35</td>
<td>5.05</td>
<td>5.85</td>
<td>1</td>
<td>48.2</td>
<td>14.4</td>
<td>44.45</td>
<td>3.45</td>
<td>1.4</td>
<td>7.45</td>
<td>2</td>
<td>10.5</td>
<td>207.1</td>
</tr>
<tr>
<td>927</td>
<td>11</td>
<td>30.25</td>
<td>10.3</td>
<td>7.35</td>
<td>5.3</td>
<td>17.9</td>
<td>39</td>
<td>30.25</td>
<td>24</td>
<td>30.45</td>
<td>18.5</td>
<td>1.85</td>
<td>0.65</td>
<td>12.05</td>
<td>4.95</td>
<td>232.8</td>
</tr>
<tr>
<td>1001</td>
<td>12</td>
<td>36.2</td>
<td>6.95</td>
<td>11.9</td>
<td>5.3</td>
<td>6.25</td>
<td>10.45</td>
<td>19.35</td>
<td>16.4</td>
<td>59.9</td>
<td>2.75</td>
<td>3.25</td>
<td>5.05</td>
<td>4</td>
<td>0</td>
<td>187.75</td>
</tr>
<tr>
<td>1004</td>
<td>13</td>
<td>21.3</td>
<td>5.2</td>
<td>21</td>
<td>8.2</td>
<td>6.1</td>
<td>4.95</td>
<td>21.75</td>
<td>20.75</td>
<td>59.15</td>
<td>2.65</td>
<td>1.55</td>
<td>4.05</td>
<td>12.5</td>
<td>0</td>
<td>189.15</td>
</tr>
<tr>
<td>1011</td>
<td>14</td>
<td>20.85</td>
<td>20.65</td>
<td>31.25</td>
<td>10.7</td>
<td>13.05</td>
<td>7.25</td>
<td>12.4</td>
<td>29.45</td>
<td>98.5</td>
<td>3.1</td>
<td>2.65</td>
<td>1.55</td>
<td>32.15</td>
<td>2.75</td>
<td>286.3</td>
</tr>
<tr>
<td>1015</td>
<td>15</td>
<td>17.1</td>
<td>23.05</td>
<td>18.25</td>
<td>17.75</td>
<td>14.45</td>
<td>0</td>
<td>43.25</td>
<td>15</td>
<td>89.3</td>
<td>8.6</td>
<td>6.95</td>
<td>3.2</td>
<td>6.85</td>
<td>3.75</td>
<td>267.5</td>
</tr>
<tr>
<td>1018</td>
<td>16</td>
<td>40.75</td>
<td>37.7</td>
<td>42.6</td>
<td>16.75</td>
<td>22.2</td>
<td>0</td>
<td>42.15</td>
<td>18.75</td>
<td>66.25</td>
<td>3.1</td>
<td>1.5</td>
<td>4.5</td>
<td>30.7</td>
<td>1</td>
<td>327.95</td>
</tr>
<tr>
<td>1022</td>
<td>17</td>
<td>34.45</td>
<td>16.35</td>
<td>17.65</td>
<td>3.65</td>
<td>5.75</td>
<td>0</td>
<td>38.95</td>
<td>34.2</td>
<td>36.2</td>
<td>5.85</td>
<td>1.5</td>
<td>4.35</td>
<td>0</td>
<td>0</td>
<td>198.9</td>
</tr>
<tr>
<td>1115</td>
<td>18</td>
<td>21.3</td>
<td>10.3</td>
<td>14.5</td>
<td>5.5</td>
<td>1.65</td>
<td>0</td>
<td>15.8</td>
<td>4.75</td>
<td>34.65</td>
<td>10.05</td>
<td>3.4</td>
<td>2.35</td>
<td>11.05</td>
<td>1.65</td>
<td>136.95</td>
</tr>
</tbody>
</table>

PPR = recyclable paper, CC = corrugated cardboard, BGS = plastic film, TRP = #1 and #2 plastic containers, RGD = rigid plastics, YRD = yard waste, FD = food waste, WD = wood, ORG = other organics, FE = ferrous containers, AL = aluminum containers, GLS = glass containers, INORG = other inorganics, ELC = electronics

Table B-3: Net Weight of Materials Sampled from District 31